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ABSTRACT

Because many handicapped students leave high school without a reasonable knowledge of the world of work, a clear understanding of self in relationship to potential occupational pursuits, or a mastery of the basic skills required to function in different occupational roles, the National Center for Research in Vocational Education developed and evaluated a set of instructional materials entitled Math on the Job. Thirty instructional booklets and a teacher's guide were designed for use with mainstreamed mentally retarded, learning disabled, and emotionally disturbed high school students. Drafts of the booklets were pilot tested at four sites. Major revisions were suggested and implemented. Next, eight booklets were field tested with 80 treatment-group and 40 control-group students at the four test sites. Although program students scored higher on the posttest than did the control group students, their gains in knowledge were relatively small. Therefore, the materials were revised extensively and reformatted. (Appendixes to this report include an occupational definitions booklet; lists of occupational tasks, related math skills, and content specifications for 30 occupations; various evaluation forms; the project pre- and posttests; a fact sheet, draft brochure and draft news release describing the booklets; and a marketing plan.) (MN)

Improving the Basic Math Skills and Job Awareness of Handicapped Students

FINAL REPORT

The National Center for Research
in Vocational Education
The Ohio State University
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FOREWORD

Many handicapped students experience difficulty in entering the labor market. In many cases, they leave high school without a reasonable knowledge of the world of work, a clear understanding of self in relationship to potential occupational pursuits, or a mastery of the basic skills required to function in different occupational roles. To assist students in this transition from school to work and to reinforce basic skills education, the National Center has developed and evaluated a set of instructional materials entitled MATH ON THE JOB.

These materials will help mentally retarded, learning disabled, and seriously emotionally disturbed high school students acquire information regarding thirty entry-level occupations. The students will discover how various math concepts and skills are used in the occupations, apply different math skills in the performance of selected occupational tasks, and consider the educational and training requirements for preferred occupations.

This project was a broadly based effort incorporating many agencies and individuals. We are particularly indebted to the following individuals for their participation in the pilot and field tests: Mr. James Baker, Career Education Coordinator, Special School District of St. Louis County, Town and Country, Missouri; Mr. Philip Beckwith, Vocational Education Consultant, School District of Greenville County, Greenville, South

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We appreciate the skills of Ms. Barbara Hannon, Ms. Debbie Fladen, and Ms. Marilyn Willhoff for typing and word processing support. Graphics were provided by Mr. Jaime Lombardo and Ms. Sue Dziura. Ms. Judy Boylson laid out and assembled the booklets. Special appreciation is given also to Dr. Lorella McKinney who provided the initial conceptualization to the effort and provided project leadership during the first two years of the contract cycle.

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Robert E. Taylor
Executive Director
The National Center for Research
in Vocational Education

EXECUTIVE SUMMARY

The Improving the Basic Math Skills and Job Awareness of Handicapped Students project was sponsored by a grant from the U.S. Department of Education, Office of Special Education and Rehabilitation Sevices. The primary purpose of the three year project was to design, develop, and evaluate instructional materials to ease the transition of special needs students from school to work. The materials are designed for use with the mainstreamed mentally retarded, learning disabled, and emotionally disturbed high school students.

The Math on the Job booklets provide special needs high school students an opportunity to explore careers and practice math skills. These booklets help students learn how basic math skills are used by workers on the job and contain occupationally-specific math problems and career information.

In order to make the materials appropriate for the target audience, the initial developmental process encompassed several major tasks: (1) selection of occupations appropriate for material development, (2) identification of instructional strategies to reach the target audience, and (3) identification of occupational tasks and content specifications. Using this information, project staff developed drafts of the material and pilot-tested them at four sites. As a result of the pilot test, major revisions were suggested and implemented.

After the material was revised, eight of the booklets were field-tested with students at the four test sites. An intake assessment was administered to 80 students in the program group

and 40 students in the control group to assure that the groups were evenly matched. Following the use of the booklets, the students were given a posttest to measure growth in both affective and cognitive areas. While the program students scored higher than the control students on the cognitive measures, the differences, though significant, were small. This, in addition to the teacher's overall evaluation of the materials, suggested that the materials required substantial revision.

Using the suggestions obtained during field site visits and from evaluation forms, the field-tested materials were extensively revised and reformatted. A Product Review Evaluation (PRE) was initiated and, overall, the reviewers found the new format to be a vast improvement in the product.

The dissemination efforts of the final 30 booklets and a teacher's guide have been initiated. These efforts are being made at the intra-district, regional, and national levels. In addition, several commercial publishers have expressed interest in publishing the materials.

PROJECT DESCRIPTION

Background

While the school-to-work transition is difficult for any student to make, it represents an especially difficult step for the handicapped. Evidence of the magnitude of this problem is reflected in the large numbers of handicappped persons who are both unemployed and underemployed. For example, in 1978, Edwin Martin, then Deputy Commissioner of the Bureau of Education for the Handicapped (BEH), reported that of the handicapped leaving school during 1972-73, 39 percent were unemployed (including those requiring sheltered environments or total care) and 40 percent were underemployed (Buzzel and Martin 1978). Related evidence shows that the United States has one of the highest youth unemployment rates in the world, which is aggravated by an annual influx into the labor market of approximately 2.5 million young Americans, many of whom lack adequate marketable skills. As a consequence, for handicapped students "the labor market is increasingly competitive with many of the traditional unskilled jobs normally associated with employment for some handicapped populations disappearing" (Gardner and Warren, 1978). In another position paper released by BEH it was noted that, "The fact that a substantial number of handicapped students leave the educational system without basic and occupational skills may contribute to the problem of unemployed handicapped adults" (Halloron and Saunders, 1978).

Clearly, there is a need to provide assistance to handicapped youth in preparing for the world of work. Furthermore, available evidence suggests that such assistance must be multifaceted if it is to be maximally effective. Evidence gleaned from the area of career development indicates that this assistance must enhance the students'/youths' understanding of self, knowledge of the world of work, and awareness of critical correspondences among these key factors. At the same time, any such assistance must serve to help alleviate key basic skills deficiencies that may hinder the students' capacity to benefit fully from learning experiences designed to prepare them for entry into the world of work.

Project Overview

The primary goal of this effort was to develop an integrated set of learning materials that provide mainstreamed learning disabled, mentally retarded, and seriously emotionally disturbed high school students an opportunity to work toward and prepare for the transition from school to work. These materials were to focus upon helping students learn how the basic mathematics skills and knowledge they acquire in high school are used by different workers in performing work-related tasks. The specific instructional outcomes sought were --

- to help students acquire information about selected entry-level occupations (i.e., occupations for which training is generally provided at the secondary level);
- to help students discover how different workers use basic math skills on the job every day;

- to help students realize that the basic math skills taught at the secondary level are fundamental to the performance of many jobs;
- to provide students with an opportunity to perform (simulated) occupational tasks that require the application of their basic math skills;
- to help students become more familiar with the entry requirements for the occupations addressed; and
- to provide students with an opportunity to consider the future education and training requirements for preferred occupations.

A three-year research project was conducted to develop, evaluate, revise, and plan the dissemination of the instructional materials designed to address the needs of handicapped students. Specifically, the objectives of the project were to--

- prepare a set of content specifications for the proposed materials.
- develop and pilot test the draft version of the set of materials.
- revise and refine the proposed set of booklets and related materials.
- diseminate project results and materials.

Accomplishment of the major project objectives is detailed in the remaining sections of this report.

DEVELOPMENTAL PROCESS

The developmental process encompassed several major tasks: (1) selection of occupations appropriate for material development, (2) definition of the target audience, and (3) development of content specifications.

Method of Selecting Occupations

Three important criteria were established in order to determine the entry-level occupations appropriate for material development. These criteria were --

1. The occupations should be the kinds of occupations that students can experience in a typical high school vocational education program.
2. The occupations should be those occupations for which the relative number of potential openings are large and do not require college level degrees for entry.
3. The occupations should be suitable for students who represent various levels and types of special needs.

Drawing upon Arthur De W. Smith's (1975) work on generic occupational skills and information from the U. S. Department of Labor (1982), a list of forty-four occupations (see Appendix A) was developed. This list and an accompanying occupational task/math competency definitions booklet (see Appendix B) were sent to three special educators in order to obtain a rating of each occupation. Dictionary of Occupational Titles (DOT) codes, general training levels, and median hourly wage ranges for the forty-four occupations are detailed in Table 1.

Each special educator who rated the occupations has expertise in one of the targeted special needs areas -- learning disabled, mentally retarded, or seriously emotionally

TABLE 1

SELECTED DESCRIPTIONS OF FORTY-FOUR OCCUPATIONS

Occupational Title	DOT Number[a]	Number of Jobs in '80[b]	Expected Growth[b]	Geographical Location of Job[b]	Source of Training[b]	Wages (1980)[bc]
Cook	313	1,100,000	average	diffuse	voc. ed., job	7.16
Motor-vehicle mechanic	620	845,000	faster	diffuse	voc. ed., job	9.78
Carpenter	860	970,000	average	diffuse	apprenticeships	12.42
Cashier	211	1,600,000	faster	diffuse	H.S., voc. ed., job	3.35-8.79
Janitor	382	2,751,000	NA	NA	job	NA
Maintenance person	899	NA	NA	NA	NA	NA
Painter	740;741;840	382,000	average	diffuse	apprentice, job	12.00
Receiving clerk	222	NA	NA	NA	NA	NA
Truck driver, local	906	1,700,000	average	large cities	job	8.71
Maintenance mechanic	620	507,000	average	industrialized areas	apprentice, job	9.53
Metal product assembler	809	NA	average	industrialized areas	job	4.00-9.00
Plumber	862	407,000	average	NA	apprenticeships	12.98
Sales clerk	260-290	3,300,000	average	diffuse	H.S., voc. ed., job	3.35-6.83
Waiter/waitress	311	1,700,000	average	diffuse	job	2.04-3.64 plus tips
Secretary/clerk-typist/stenographer	201	2,500,000	faster	diffuse	H.S.	6.50
Taxi driver	913,463-018	NA	NA	NA	NA	NA
Packaging-machine mechanic[d]						
Tractor-trailer driver	905	575,000	average	NA	job	12.93
Combination welder	819	573,000	average-faster	South and West	voc. ed., job	9.00-13.00
Construction worker	869	1,000,000	average	diffuse	job	9.80
Electrician	*	560,000	average	urban areas	apprentice, job	11.73
Machinist	600	303,000	average	urban areas	apprentice	9.63
Meat cutter	316	190,000	slower	diffuse	apprentice, job	10.14
Barber/cosmetologist	330;332	625,000	average	diffuse	6 mos.-1 yr. spec. tr.	3.35-9.20
Bookkeeper	210	1,700,000	average	diffuse	H.S.-2 years post H.S.	6.00
Construction equipment mechanic	620	NA	NA	NA	NA	NA
Farmer	421	1,447,000	slower	rural	post H.S., job	variable
Radio and TV service person	720	83,000	faster	diffuse	H.S.-2 years post H.S.	5.75-10.00
Sheet-metal worker	619	108,000	average	large cities	apprenticeship	13.07
Accounting clerk	210	1,700,000	average	diffuse	H.S.-2 years post H.S.	6.00
Computer service technician	828.261-014	83,000	much faster	large cities	1-2 years post H.S.	9.60
Draftsperson	00-01	322,000	faster	NA	H.S.-2 years post H.S.	6.75
Heavy equipment operator	850	270,000	average	diffuse	apprentice	11.00-14.00
Medical-laboratory technician	078	205,000	faster	NA	2 years post H.S.	5.87
Nursing aide/assistant	355.674-014	NA	NA	NA	NA	NA
Programmer	020.187	228,000	faster	urban areas	H.S.-4 years post H.S.	variable
Dietitian	077	44,000	faster	NA	4 years post H.S.	10.00
Linesperson	821.261-014	70,000	slower	NA	voc. ed., job	9.30
Police worker	375	495,000	average	diffuse	H.S.-post H.S	7.50
Architectural technologist[d]						
Insurance salesperson	250.257-010	325,000	average	diffuse	H.S.-4 years post H.S.	10.59
Respiratory therapy technician	079	50,000	much faster	NA	1 year post H.S.	NA
Legal assistant	119.267-026	36,000	much faster	NA	H.S.-4 years post H.S.	9.00
Surveyor	018	61,000	average	NA	postsecondary, job	10.90

[a]The first three digits of the DOT number identify a particular occupational group as found in the Dictionary of Occupational Titles (DOT) (1977), pp. xvi-xvii. The middle three digits are the worker ratings relative to data, people, and things (DOT, pp. xvii-xviii). The last three digits serve to differentiate a particular occupation from all others (DOT, p. xviii).

[b]Information is taken from the Occupational Outlook Handbook, 1982-83 Edition.

[c]Figures refer to mean or model hourly wages, usually based on a subgroup of the larger occupational group; thus this figure should be used cautiously. Actual wages very with such factors as training, experience, and geographic area.

[d]These titles are not included in the DOT. The titles and information about them can be found in the Canadian Classification and Dictionary of Occupations, Volume 1, 1971.

[e]Electricians are employed in numerous industries; therefore, electrician has many DOT codes.

NA indicates the information is not available in the 1982-83 edition of the Occupational Outlook Handbook.

disturbed high school students. The special educators were selected from a list of names (1) developed from nominations offered by representatives of national organizations concerned with the special needs groups and/or (2) consisting of nationally prominent practitioner researchers in the three areas.

Taking into consideration the needs and capabilities of the special needs group that each represented, the special educators rated the forty-four occupations with respect to how important it would be to include a specific occupation as one of the thirty occupations for this project. Results of this Occupational Rating Survey are presented in Table 2.

In Table 2, each consultant's rating for each occupation is shown along with a sum of the ratings. The forty-four occupations are ranked in the far left column. After reviewing the rankings listed in Table 2, it was apparent that further analysis was needed, since occupations numbering thirty through thirty-six each carried a rank of 7. Because of the need to differentiate among the occupations ranked 7, weighted ratings were calculated.

The weighted ratings for each handicapping condition (i.e., serious emotional disturbance, mental retardation, and learning disability) were determined by multiplying each consultant's rating for an occupation by a percentage factor. The percentage factors (enrollment incidences for each of the handicapped groups--seriously emotionally disturbed, mentally retarded, and learning disabled) are determined by dividing the

TABLE 2

CONSULTANTS' RATINGS, SUMS OF RATINGS AND RANK FOR FORTY-FOUR OCCUPATIONS

Rank	Occupation	Consultants' Ratings			SUM
		ED	MR	LD	
1	Cook	4	4	4	12
1	Motor-vehicle mechanic	4	4	4	12
2	Carpenter	3	4	4	11
2	Cashier	4	4	3	11
2	Janitor	4	4	3	11
2	Maintenance person	4	3	4	11
2	Painter	3	4	4	11
2	Receiving clerk	4	3	4	11
2	Truck driver, local	3	4	4	11
3	Maintenance mechanic	4	2	4	10
3	Metal product assembler	4	4	2	10
3	Plumber	3	4	3	10
3	Sales clerk	3	3	4	10
3	Waiter/waitress	2	4	4	10
4	Secretary/clerk-typist (stenographer)	3	2	4	9
4	Taxi driver	2	4	3	9
4	Packaging-machine mechanic	4	2	3	9
4	Tractor-trailer driver	2	4	3	9
5	Combination welder	1	4	3	8
5	Construction worker	1	3	4	8
5	Electrician	3	1	4	8
5	Machinist	3	1	4	8
5	Meat cutter	2	3	3	8

TABLE 2 (continued)

Rank	Occupation	Consultants' Ratings			SUM
		ED	MR	LD	
6	Barber/cosmetologist	2	2	3	7
6	Bookkeeper	3	1	3	7
6	Construction equipment mechanic	1	2	4	7
6	Farmer	1	2	4	7
6	Radio/TV service person	3	1	3	7
6	Sheet-metal worker	3	1	3	7
7	Accounting clerk	3	1	2	6
7	Computer service technician	3	1	2	6
7	Draftsperson	3	1	2	6
7	Heavy equipment operator	1	2	3	6
7	Medical-laboratory technician	2	1	3	6
7	Nursing aide/assistant	2	1	3	6
7	Programmer	3	1	2	6
8	Dietitian	2	1	2	5
8	Linesperson	1	1	3	5
8	Police worker	1	1	3	5
9	Architectural technologist	1	1	2	4
9	Insurance salesperson	1	1	2	4
9	Respiratory therapy technician	1	1	2	4
10	Legal assistant	1	1	1	3
10	Surveyor	1	1	1	3

numbers of individuals enrolled in each group by the total enrollment in special education programs in elementary and secondary schools in the United States in fall, 1980. The percentage factors are seriously emotionally disturbed, 6 percent; mentally retarded, 17 percent; and learning disabled, 39 percent. Enrollment statistics are taken from Digest of Education Statistics, 1982. The percentage factor represented the enrollment incidence specific to each type of handicapping condition. The sum or total of the combined weighted ratings and the resulting rank for each occupation are shown in Table 3.

Table 4 is a listing of the occupations by rank and is based upon the weighted calculations from Table 3. Once more, further study and analysis were required because the 33rd through 37th occupations received the same rank of 27.

The differences between the rankings resulting from the consultant ratings and the calculated weighted ratings are given in Table 5. See Table 6 for the ordered listing of occupations resulting from the discrepancies shown in Table 5. Table 6 also identifies those occupations having (1) 200,000 or more workers, (2) average to faster than average expected growth, and (3) widely dispersed job availability.

Finally, a review of the DOT code numbers and the occupational tasks related to each occupation resulted in the identification of several occupations having fundamental similarities. Those occupations having similarities were merged as related occupations and are shown accordingly below.

TABLE 3

OCCUPATIONAL WEIGHTED RATINGS, SUMS OF WEIGHTED RATINGS, AND RANK SCORES AND RATING BASED ON PERCENT OF ENROLLMENT IN EACH HANDICAPPING GROUP[a]

Rank	Occupation	Weighted Ratings			SUM
		ED	MR	LD	
1	Cook	.24	.68	1.56	2.48
1	Motor-vehicle mechanic	.24	.68	1.56	2.48
2	Carpenter	.18	.68	1.56	2.42
8	Cashier	.24	.68	1.17	2.09
8	Janitor	.24	.68	1.17	2.09
4	Maintenance person	.24	.51	1.56	2.31
2	Painter	.18	.68	1.56	2.42
4	Receiving clerk	.24	.51	1.56	2.31
2	Truck driver, local	.18	.68	1.56	2.42
6	Maintenance mechanic	.24	.34	1.56	2.14
16	Metal product assembler	.24	.68	.78	1.70
10	Plumber	.18	.68	1.17	2.03
5	Sales clerk	.18	.51	1.56	2.25
3	Waiter/waitress	.12	.68	1.56	2.36
9	Secretary/clerk-typist (stenographer)	.18	.34	1.56	2.08
11	Taxi driver	.12	.68	1.17	1.97
15	Packaging-machine mechanic	.24	.34	1.17	1.75
11	Tractor-trailer driver	.12	.68	1.17	1.97
13	Combination welder	.06	.68	1.17	1.91
7	Construction worker	.06	.51	1.56	2.13

TABLE 3 (continued)

Rank	Occupation	Weighted Ratings			SUM
		ED	MR	LD	
13	Electrician	.18	.17	1.56	1.91
13	Machinist	.18	.17	1.56	1.91
14	Meat cutter	.12	.51	1.17	1.80
17	Barber/cosmetologist	.12	.34	1.17	1.63
19	Bookkeeper	.18	.17	1.17	1.52
12	Construction equipment mechanic	.06	.34	1.56	1.96
12	Farmer	.06	.34	1.56	1.96
22	Radio/TV service person	.18	.17	.87	1.22
22	Sheet-metal worker	.18	.17	.87	1.22
22	Accounting clerk	.18	.17	.78	1.22
22	Computer service technician	.18	.17	.78	1.22
23	Draftsperson	.18	.17	.78	1.13
18	Heavy equipment operator	.06	.34	1.17	1.57
20	Medical-laboratory technician	.12	.17	1.17	1.46
20	Nursing aide/assistant	.12	.17	1.17	1.46
22	Programmer	.18	.17	.78	1.22
24	Dietitian	.12	.17	.78	1.07
21	Linesperson	.06	.17	1.17	1.40
21	Police worker	.06	.17	1.17	1.40
25	Architectural technologist	.06	.17	.78	1.01
25	Insurance salesperson	.06	.17	.78	1.01
25	Respiratory therapy technician	.06	.17	.78	1.01
26	Legal assistant	.06	.17	.39	.62
26	Surveyor	.06	.17	.39	.62

[a]Enrollment statistics for each handicapping group are taken from W. V. Grant and L. J. Eiden, Digest of Education Statistics 1982 (Washington, D.C.: National Center for Statistics, U.S. Government Printing Office), 1982.

TABLE 4

OCCUPATIONS ORDERED BY RANK BASED UPON WEIGHTED RATINGS

RANK	OCCUPATION
1	Cook
1	Motor-vehicle mechanic
2	Carpenter
2	Painter
2	Truck driver, local
3	Waiter/waitress
4	Maintenance person
4	Receiving clerk
5	Sales clerk
6	Maintenance mechanic
7	Construction worker
8	Cashier
8	Janitor
9	Secretary/clerk-typist (stenographer)
10	Plumber
11	Taxi driver
11	Tractor-trailer driver
12	Construction equipment mechanic
12	Farmer
13	Combination welder
13	Electrician
13	Machinist
14	Meat cutter
15	Packaging-machine mechanic
16	Metal product assembler
17	Barber/cosmetologist
18	Heavy equipment operator
19	Bookkeeper
20	Medical-laboratory technician
20	Nursing aide/assistant
21	Linesperson
21	Police worker
22	Radio/TV service person
22	Sheet-metal worker
22	Accounting clerk
22	Computer service technician
22	Programmer
23	Draftsperson
24	Dietitian
25	Architectural technologist
25	Insurance salesperson
25	Respiratory therapy technician
26	Legal assistant
26	Surveyor

TABLE 5

OCCUPATIONAL RANK BASED ON
DISCREPANCIES IN CONSULTANTS' RATING

	Consultants' Ranking	Weighted Ranking[a]	Discrepancy in Rankings	Rank Based on Discrepancy in Rank
Cook	1	1	0	1
Motor-vehicle mechanic	1	1	0	1
Carpenter	2	2	0	1
Cashier	2	8	6	5
Janitor	2	8	6	5
Maintenance person	2	4	2	2
Painter	2	2	0	1
Receiving clerk	2	4	2	2
Truck driver, local	2	2	0	1
Maintenance mechanic	3	6	3	3
Metal product assembler	3	16	13	10
Plumber	3	10	7	6
Sales clerk	3	5	2	2
Waiter/waitress	3	3	0	1
Secretary/clerk-typist (stenographer)	4	9	5	4
Taxi driver	4	11	7	6
Packaging-machine mechanic	4	15	11	9
Tractor-trailer driver	4	11	7	6
Combination welder	5	13	8	7
Construction worker	5	7	2	2
Electrician	5	13	8	7
Machinist	5	13	8	7
Meat cutter	5	14	9	8
Barber/cosmetologist	6	17	11	9

TABLE 5 (continued)

	Consultants' Ranking	Weighted Ranking [a]	Discrepancy in Rankings	Rank Based on Discrepancy in Rank
Bookkeeper	6	19	13	10
Construction equipment mechanic	6	12	6	5
Farmer	6	12	6	5
Radio/TV service person	6	22	16	12
Sheet-metal worker	6	22	16	12
Accounting clerk	7	22	15	11
Computer service technician	7	22	15	11
Draftsperson	7	23	16	12
Heavy equipment operator	7	18	11	9
Medical-laboratory technician	7	20	13	10
Nursing aide/assistant	7	20	13	10
Programmer	7	22	15	11
Dietitian	8	24	16	12
Linesperson	8	21	13	10
Police worker	8	21	13	10
Architectural technologist	9	25	16	12
Insurance salesperson	9	25	16	12
Respiratory therapy technician	9	25	16	12
Legal Assistant	10	26	16	12
Surveyor	10	26	16	12

[a]Rank results from multiplying the rank value of consultants' ratings times incidence factor (ED = 6%; MR = 17%; and LD = 39%)

TABLE 6

RANK OF OCCUPATIONS BY DISCREPANCY BETWEEN RANKINGS
INCLUDING JOB SUPPLY, GROWTH, AND DISTRIBUTION INFORMATION

RANK	OCCUPATION
1	Cook*ab
1	Motor-vehicle mechanic*ab
1	Carpenter*ab
1	Painter*ab
1	Truck driver, local*a
1	Waiter/waitress*ab
2	Maintenance person[nl]
2	Receiving clerk[nl]
2	Sales clerk*ab
2	Construction worker*ab
3	Maintenance mechanic*a
4	Secretary/clerk-typist (stenographer)*ab
5	Cashier*ab
5	Janitor*nl
5	Construction equipment mechanic[nl]
5	Farmer*
6	Plumber*a
6	Taxi driver[nl]
6	Tractor-trailer driver*a
7	Combination welder*ab
7	Electrician*ab
7	Machinist*ab
8	Meat cutter*b
9	Packaging-machine mechanic[nl]
9	Barber/cosmetologist*ab
9	Heavy equipment operator*ab
10	Metal product assembler[a]
10	Bookkeeper*ab
10	Medical-laboratory technician*ab
10	Nursing aide/assistant[nl]
10	Linesperson
10	Police worker*ab
11	Accounting clerk*ab
11	Computer service technician[a]
11	Programmer*ab
12	Radio/TV service person[ab]
12	Sheet-metal worker[a]
12	Draftsperson*a
12	Dietitian[a]
12	Architectural technologist[nl]
12	Insurance salesperson*ab
12	Respiratory therapy technician[a]
12	Legal assistant[a]
12	Surveyor[a]

* = over 200,000 jobs

a = average to faster than average growth in occupation

b = jobs available throughout country

nl = information not given

- Accounting Clerk/Bookkeeper
- Janitor/Maintenance Person
- Motor-Vehicle Mechanic/Construction Equipment Mechanic
- Maintenance Mechanic/Packaging-Machine Mechanic

The occupations receiving low ranking in Tables 2, 4, and/or 6 are listed in Table 7. Of those ranked quite low, nine with the highest sum of rankings were deleted. They include draftsperson, dietitian, architectural technologist, insurance salesperson, respiratory therapy technician, legal assistant, linesperson, police worker, and surveyor. Two were retained; namely, radio/TV service person and sheet-metal worker. The preceding two occupations received low rankings in only one of the three tables, where as the deleted occupations ranked low in two or three of the tables. On the basis of this analysis the following thirty occupations were selected.

1. Accounting clerk/bookkeeper
2. Barber/cosmetologist
3. Carpenter
4. Cashier
5. Combination welder
6. Computer service technician
7. Construction laborer
8. Cook
9. Electrician
10. Grain farmer
11. Heavy equipment operator
12. Janitor/maintenance person
13. Machinist
14. Maintenance mechanic
15. Meat cutter
16. Metal product assembler
17. Motor-vehicle mechanic
18. Nurse assistant
19. Painter
20. Plumber
21. Programmer
22. Radio/TV service person
23. Receiving clerk
24. Sales clerk
25. Secretary/clerk-typist

TABLE 7

OCCUPATIONS RANKED LOW
IN ONE OR MORE TABLES

	Ranking in Table 1	Ranking in Table 3	Ranking in Table 5	Sum of Rankings
Dietitian	8	24	12	44
Linesperson	8	X	X	8
Police worker	8	X	X	8
Architectural technologist	9	25	12	46
Insurance salesperson	9	25	12	46
Respiratory therapy technician	9	25	12	46
Legal assistant	10	26	12	48
Surveyor	10	26	12	48
Draftsperson	X	23	12	35
Radio/TV service person	X	X	12	12
Sheet-metal worker	X	X	12	12

X indicates that ranking did not fall below 7 in table 1, below 22 in table 3, and below 11 in table 5.

26. Sheet-metal worker
27. Taxi driver
28. Tractor-trailer driver
29. Truck driver, local
30. Waiter/waitress

Definition of Target Audience

The materials were designed to provide mainstreamed learning disabled, mentally retarded, and seriously emotionally disturbed high school students an opportunity to learn how basic mathematics skills are used by different workers in performing work related tasks.

The target populations are defined as follows--

- Learning disabled students have a disorder in one or more of the basic psychological processes involved in understanding or in using spoken or written language. The disorder may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include students who have learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, of emotional disturbance, or of environmental, cultural or economic disadvantages.

- Mentally retarded students have significantly subaverage general intellectual functioning. The subaverage functioning exists concurrently with deficits in adaptive behavior manifested during the developmental period and affects a student's educational performance.

- Seriously emotionally disturbed students exhibit one or more of the following characteristics over a long period of time and to a marked degree:

  1. an inability to learn, which cannot be explained by intellectual sensory, or health factors;

  2. an inability to build and maintain satisfactory interpersonal relationships with peers and teachers;

3. inappropriate types of behavior or feelings under normal circumstances;

4. a general pervasive mood of unhappiness or depression; or

5. a tendency to develop physical symptoms or fears associated with personal or school problems.

The term includes students who are schizophrenic but does not include students who are socially maladjusted, unless it is determined that they are seriously emotionally disturbed.

Content Specifications

In order to develop approriate materials, a great deal of secondary research was conducted to identify (1) specific learning problems, (2) skill development needs, and (3) instructional strategies to overcome the problems and meet the needs of the target audience. Content specifications were derived on the basis of this analysis.

The specific learning problems identified are shown in Table 8. Major problem areas for all three groups include short attention spans, language problems, underachievement in reading, motivational problems, and a high expectancy for failure.

The identified basic skill needs of the target population are shown in Table 9. These needs include readiness skills, communication skills, personal-social skills, and physical coordination skills.

To overcome the learning problems and to meet the skill development needs of the target population, specific instructional strategies were identified. These strategies are

Table 8

Learning Problems of Target Audience

PROBLEMS	Mentally Retarded	Learning Disabled	Behavior Handicapped
Difficulty in attending to a variety of stimuli	x	x	
Easily distracted	x	x	x
Short attention spans	x	x	x
Short-term memory deficit	x	x	
Don't employ learning strategies (rehearse, cluster)	x	x	x
Same learning stages, slower rate	x		
Language problems	x	x	x
Underachievement in relation to mental age, especially reading	x	x	x
Motivational problems	x	x	x
High expectancy for failure	x	x	x
Poor self-concepts	x	x	x
Hyperactivity		x	x
Percep-motor impair		x	
Emotional lability		x	x
Coordination deficits	x	x	x
Impulsivity		x	x
Specific academic problems		x	
Abusive			x
Destructive			x
Unpredictable			x
Irresponsible			x
Quarrelsome			x
Bossy			x
Defiant			x
Irritable			x
Jealous			x
Withdrawn			x
Inability to build/maintain good personal relationships		x	x
Mostly boys (aggressive, in sbh)		x	x
Low end of IQ scale	x	x	x
Inflexible	x	x	x
Long-term memory problems		x	
Trouble with abstractions (e.g., "decision")	x	x	

Table 9

Skill Needs of Target Audience

NEEDS	Mentally Retarded	Learning Disabled	Behavior Handicapped
Readiness skills:			
Sit still pattend	x	x	x
Follow directions	x	x	x
Discriminate stimuli	x	x	x
Develop language	x	x	x
Increase coordination	x	x	x
Develop self-help skills	x	x	x
Interact with peers	x	x	x
Communication skills	x	x	x
Personal-social skills	x	x	x
PE skills	x	x	x

Table 10

Instructional Strategies for Target Audience

STRATEGIES	Mentally Retarded	Learning Disabled	Behavior Handicapped
Sequence learning tasks	x	x	x
Drill and repetition	x		
Verbal mediation	x	x	
Increase motivation	x	x	x
Structure of familiarity	x	x	x
Consistent reinforcement	x	x	x
Continuous assessment	x	x	x
Feedback	x	x	x
Work at correct level (realistic)		x	x
Clear instructions		x	x
Special physical arrangements		x	x
Multisensory		x	x
Teach social skills	x	x	x
Behavior modification	x	x	x

shown in Table 10 and include sequencing of learning tasks, consistent reinforcement, feedback, continuous assessment, and clear instructions.

By reviewing Smith's work on generic occupational skills, information from the U.S. Department of Labor (op cit) and many other sources, the specific job-related tasks for each occupation were identified. Additionally, the math-related skills needed for each job task were detailed (see Appendix C).

Using the above information, content specifications for each occupation were developed (see Appendix D). Each specification includes--

(1) specific instructional objectives, both general and mathematics related; and

(2) possible simulations or work-related examples to use in material development.

In addition, several general principles were followed during the development process:

- Each math-related application should be very explicit, provide clear and detailed instructions, and ensure ample opportunity for repetition, practice, feedback, and reinforcement.
- Specific learning tasks should be divided into small closely sequenced steps in order to foster improved performance.
- The activities should be motivational, involving both interesting tasks and appropriate elements of graphic design to heighten their appeal to learners.
- The reading level should be as low as possible while conveying concepts that are relevant to adolescents and adults.

These principles were used to develop a prototype booklet and pilot-test materials.

Material Description

In order to develop appropriate materials, project staff used--

1. the definitions of the target population;
2. the identified problems of the target population;
3. the identified basic skills needs of the target population;
4. the identified instructional strategies;
5. the identified occupational tasks; and
6. the contents specifications

The resulting materials for each occupation consisted of a booklet and two envelopes containing additional resource materials.

Each booklet contained--

- an advance organizer to familiarize students with the occupation
- task descriptions of the occupation
- a description of the work environment
- items that the worker must be able to do
- descriptions of the tools and machines the worker uses
- a description of how the worker uses math
- an introduction and overview to a simulation
- a self-assessment instrument

- a description of how to get a job as the worker
- brief descriptions of similar jobs
- an introduction to a group role simulation
- suggestions of things to do outside of the classroom to learn more about the occupation
- a glossary

The first of the two resource material envelopes contained individual simulation exercise. In the individual simulation, the students were asked to assume the role of the worker and to perform math-related tasks. A role-card, detailed instructions, and realistic forms were provided to facilitate this exercise.

The second envelope contained a group role-play/simulation exercise. In the group role-play/simulation exercise, the students were asked to assume the roles of the worker and various people with whom the worker interacts. Role cards, detailed instructions, and realistic forms also were provided to facilitate this exercise.

PILOT TEST

A pilot test was conducted in order to guide the materials revision process. A review of possible test sites focused on the population, economy, work force, target population, school size, and secondary vocational education program conditions. Four cooperating local education agencies (LEAs) were selected and agreed to participate in pilot testing and field testing the project materials. The four sites were--

- St. Louis, Missouri
- Greenville, South Carolina
- Salinas, California
- Milwaukee, Wisconsin

Initial site visits were conducted in order to familiarize the participating staff with the goals and objectives of the project, the proposed content and format of the materials, and the procedures for conducting and reporting the results.

Each participating LEA designated four general math teachers who had mainstreamed handicapped students in their classes. These teachers reviewed and used the materials with their handicapped students. The participating teachers were asked to review each occupational booklet and set of related materials. The teachers' review responses to the use of the materials were recorded on an evaluation form (see Appendix E). In addition, subject matter experts (SMEs) reviewed 15 sets of materials and recorded their responses on an evaluation form (see Appendix F).

The compiled comments and suggestions derived from the recorded responses and notes written on the material served as a guide for the revision process. This information assisted in--

- assessing the utility of the suggested procedures.
- providing insights into the effectiveness of the materials for use with selected groups of handicapped learners.
- identifying modifications and changes to improve the potential usefulness of the materials.

A complete pilot-test report was submitted to the project sponsor. Specific recommendations received from the pilot-test were to--

- change the size of the booklets
- make artwork more realistic and specific to the occupation being presented
- make the booklets less instructional in terms of math concepts and more informative with respect to career exploration and math-related skills
- lower the reading level of the material
- make the individualized and role-play simulations optional exercises for students at the discretion of the instructor
- improve the packaging of the materials
- add additional math exercises

In order to prepare the materials for the field-test, the following revisions were made--

- the booklet size was changed from 5" x 8" to 8 1/2 " x 11".

- a graphic artist was added to the project staff to develop relevant, job-specific artwork.
- math instruction was removed from the booklets.
- the organization and format of the booklets were changed to provide more information regarding career exploration and math-related skills.
- the reading level was lowered to approximately a 5th-grade level.
- the individualized and role play simulations were made optional exercises to be used at the instructor's discretion.
- the multiple envelopes of related materials were combined into one envelope and instructions and roles were condensed.
- additional math exercises were added as supplemental materials and placed in the envelope.

FIELD TEST

The field test was designed to accomplish two major purposes: (1) to provide an indication of the relative effectiveness of the instructional materials in terms of student performance, and (2) to generate data necessary to revise the field-tested materials. An intake assessment instrument was administered to 120 students before the Math on the Job program began. Following the program, a posttest was administered to 106 students.

The design of the test called for random assignment of the students to program and control groups in order to provide for even distribution on two variables: handicapping condition and sex. Due to a number of constraints operating at the time of the testing, the districts did not randomly assign students to the program group (for example, one district asked for volunteers). Other measures were not available to set up comparison groups (that is, matched pairs). The nature of the revision of the materials after posttest did not rely heavily on the comparative data. Consequently, the absence of random assignment, as will be seen later, did not prove to be a serious problem.

This section contains a description of the sample, the results of the intake assessment, the results of the posttest, and a summary of the teachers' and students' evaluations.

Sample

The students were distributed approximately evenly across the four districts participating in the program: Greenville,

SC, 22 percent; Milwaukee, WI, 26 percent; St. Louis, MO, 26 percent; and Salinas, CA, 26 percent. The sample (see Table 11) was also fairly evenly distributed between the program and control groups, 31 and 69 percent respectively). Only Milwaukee had a slightly smaller program group (26 percent). The sex ratio for the entire sample was 2 males to 1 female. This distribution held true for the program and control groups (60 and 70 percent males, respectively). However, this distribution was uneven across the districts. Greenville's subsample had 78 percent males; whereas St. Louis' sample was only 57 percent males. The other two districts were approximately at the mean.

The distribution for handicapping condition was potentially more problematic. For the entire sample, 22 percent were emotionally disturbed, 60 percent were learning disabled, and 18 percent were mentally retarded. The distribution between the program and control groups was approximately the same, but the distribution was uneven across the districts. Table 12 reveals that Greenville and Salinas had more learning disabled students, Milwaukee had more mentally retarded students, and St. Louis had more emotionally disturbed students.

An examination of the sample, then, would lead one to expect differences in test results by districts. However, differences between program and control groups, if found, will be more likely to be attributable to the Math on the Job program since these two groups are similar regarding sex and handicapping condition.

TABLE 11

Distribution of the Field Test Sample
(Pecentages on Entire Sample N=106)

	Greenville, SC	Milwaukee, WI	St. Louis, MO	Salinas, CA	Control	Program	Emotionally Disturbed	Learning Disabled	Mentally Retarded	Male	Female		Total
Greenville, SC	-	-	-	-	35	65	13	74	13	78	22	-	22
Milwaukee, WI	-	-	-	-	26	74	26	41	33	63	37	-	26
St. Louis, MO	-	-	-	-	32	68	46	43	11	57	43	-	26
Salinas, CA	-	-	-	-	32	68	0	85	15	70	30	-	26
Control	35	26	32	32	-	-	27	58	15	79	21	-	31
Program	65	74	68	68	-	-	20	60	20	61	39	-	69
Emotional Disturbed	13	26	46	0	27	20	-	-	-	70	30	-	22
Learning Disabled	74	41	43	85	58	60	-	-	-	72	28	-	60
Mentally Retarded	13	33	11	15	15	20	-	-	-	42	58	-	18
Male	78	63	57	70	79	61	70	72	42	-	-	-	67
Female	22	37	43	30	21	39	30	28	58	-	-	-	33
TOTAL	22	26	27	26	31	69	22	60	18	67	33	-	-

TABLE 12

Field Test Sample Distribution across Districts
by Handicapping Conditions
(Percentage Differences from Means for Entire Sample)

	Emotionally Disturbed	Learning Disabled	Mentally Retarded
Entire Sample	22%	60%	18%
Greenville	- 9%	+14%	- 5%
Milwaukee	+ 4%	-19%	+15%
St. Louis	+24%	-17%	- 7%
Salinas	-22%	+25%	- 3%

Intake Assessment

A 36 item test was administered in all 4 districts (see Appendix G) to determine 1) the students' knowledge levels on the content area and 2) whether the program and control groups were comparable.

It was clear from the item analysis that both the program and control groups had not already mastered the content to be taught in the Math on the Job curriculum units, achieving only 50 percent of the items. Students demonstrated greatest familiarity with knowledge associated with cooks and sales clerks (84 and 69 percent correct responses, respectively). All other occupational areas revealed a substantial lack of knowledge. General knowledge of tools, math, and occupational requirements was similarly low. These scores were essentially the same for both groups.

Analysis of variance (see Table 13) revealed that the program and control groups were not significantly different (p=.7169). Out of the 36 items, the program and control groups had an average score of 17.97 and 17.63, respectively.

TABLE 13

Field Test Intake Assessment Analysis of Variance

	n	Mean	S.D.	Sum of Squares	D.F.	Mean Square	F	Sig.
Treatment	78	17.97	4.94	3.11	1	3.11	.132	p=.7169
Nontreatment	41	17.63	4.67					
District 1	30	20.53	4.26	319.22	3	106.41	5.06	p=.0025
2	31	17.55	4.94					
3	29	17.21	4.05					
4	30	16.13	4.99					
Dist. 1 Program	20	20.70	4.64	45.38	2	22.69	1.07	p=.3464
1 Control	10	20.20	3.61					
Dist. 2 Program	20	17.95	4.96					
2 Control	10	16.70	5.29					
Dist. 3 Program	18	17.39	4.23					
Control	11	16.91	3.91					
Dist. 4 Program	20	15.80	4.87					
4 Control	10	16.80	5.41					
Entire Sample	120	17.86	4.81					

The mean scores for the districts were significantly different (p=.0025). Greenville's mean was the highest at 20.53 and Salinas' mean was the lowest at 16.13, leaving a spread of 4.4. Looking at the interaction between districts and groups, however, revealed no significant difference (p=.3464).

Posttest

A posttest was administered to the program and control groups following the completion of the Math on the Job curriculum units (see Appendix H). The test had two parts. Part 1 consisted of 10 items, the purpose of which was to measure growth in the affective domain in relationship to two learning objectives:

Affective Objective 1. To appreciate the need to be knowledgeable about the future education and training requirements for preferred occupations (5 items).

Affective Objective 2. To understand and value that workers use basic mathematics on the job every day.

Part 2 consisted of 32 items, the purpose of which was to measure growth in the cognitive domain in relationship to three learning objectives:

Cognitive Objective 1. To acquire information about selected entry-level occupations, that is, occupations for which training is generally provided at the secondary level (19 items).

Cognitive Objective 2.	To acquire information about how different workers use basic math on the job every day (8 items).
Cognitive Objective 3.	To learn the entry-level requirements for selected occupations (5 items).

Overall Test Performance

The performance scores on the affective items for the entire sample can be found in Table 14. In terms of affective objective 1, the students do seem to appreciate the need to be knowledgeable about the future education and training requirements for preferred occupations. They strongly feel that they should know the requirements and learning about them is a good use of their time. A majority (albeit, a small one) enjoy learning about the requirements and would like to know more about apprenticeship programs. However, the students on average tended not to see value in learning about the courses needed to enter different occupations.

In terms of affective objective 2, the students do seem to understand and value that workers use basic mathematics on the job every day. Four of the five items clustered at a fairly high rating on the scale. Strangely enough, a majority of the students thought that basic math skills are not very important to someone who wants to become a sales clerk.

TABLE 14

Rank Order of Posttest Affective Items
(Mean for Entire Sample on a Scale Where
3 = yes; 2 = uncertain; and 1 = no)

Rank	Item	Mean
	Affective Objective 1. To appreciate the need to be knowledgeable about the future education and training requirements for preferred occupations (5 items).	
1	All students my age should know the education and training requirements for different jobs.	2.80
2	Learning about the education and training requirements of different jobs is a [good use] of time. (inverted on test)	2.74
7	I really enjoy learning about the education and training requirements of different occupations.	2.49
8	There are apprenticeship programs I would like to know more about. (phrased as question on test)	2.37
10	I see [real] value in learning what courses I need to complete in order to enter different occupations. (inverted on test)	1.94
	Grand Mean (all items)	2.60
	Affective Objective 2. To understand and value that workers use basic mathematics on the job every day.	
3	Most workers use basic math skills on their jobs almost every day.	2.73
3	Basic math skills are an important part of every occupation.	2.73
5	Most workers need to be skilled in solving basic mathematics problems.	2.71
6	To do their jobs well, secretaries need to be able to solve basic mathematics problems.	2.65
9	Skills in basic mathematics are [...] very important to someone who wants to become a sales clerk. (inverted on test)	2.19
	Grand Mean (all items)	2.47

The performance scores on the cognitive items for the entire sample can be found in Table 15. The students' performance on all three cognitive objectives was less than satisfactory. Fifty percent or more of the students got fewer than 70 percent of the items for each objective correct. The mean scores by objectives were as follows:

Mean	Objectives
68%	Cognitive Objective 1: To acquire information about selected entry-level occupations, that is, occupations for which training is generally provided at the secondary level. (19 items)
58%	Cognitive Objective 2: To acquire information about how different workers use basic math on the job every day. (8 items)
47%	Cognitive Objective 3: To learn the entry-level requirements for selected occupations. (5 items)

These data show that students at the posttest stage had only a mediocre grasp of occupational knowledge, knew even less about how workers use math, and had a poor grasp of entry-level requirements.

TABLE 15

Rank Order of Posttest Cognitive Items
(Percent of Entire Sample Answering Correctly)

Rank	Item	Obj. 1	Obj. 2	Obj. 3
1	Cooks need to know how to (a) read and follow recipes.	89		
2	Many states require cooks to wear hats because hats (b) keep hair from falling in the food.	88		
3	Secretaries and clerk typists work (d) in offices.	85		
4	Sales clerks frequently use a (d) cash register in their jobs.	82		
5	Combination welders (b) join metal parts by heating them.	81		
5	A blender is most likely used by a (d) cook.	81		
7	Nurse aides use math in their work to (b) read thermometers.		80	
8	Cooks use math to (a) increase and decrease recipes.		77	
9	An example of a tool used by a plumber is a (c) reamer.	75		
9	Secretaries and clerk typists (b) prepare letters and reports.	75		
11	To become a good sales clerk you should (a) feel comfortable being around and talking to strangers.	73		
11	Sheet-metal workers need to know (a) good safety rules.	73		
13	One way to learn how to be a plumber is to (a) enter an apprenticeship program.			72
14	As a nurse aide or assistant, you (b) help make patients feel comfortable.	67		

TABLE 15 (Cont.)

Rank	Item	Obj. 1	Obj. 2	Obj. 3
15	Machinists use math to (b) determine depth of cut in a piece of metal.		66	
16	Sheet-metal workers use math to (c) convert scale measurements to actual size.		62	
17	Some sales clerks are paid a (c) commission.	61		
18	A machinist must be able to (a) set up and operate machine tools.	60		
19	A plumber needs to know how to (d) read blueprints and scale drawings.	59		
19	To be a secretary or clerk typist you should be (c) a high school graduate.			59
19	When oxyacetylene welding, a welder uses (c) regulators to control the flow of gases.	59		
22	Secretaries and clerk typists use math to (b) set margins on a typewriter.		56	
23	One example of a vital sign is the (d) pulse rate.	55		
23	Plumbers use math to (b) take center-to-center measurements.		55	
25	A blender is most likely used by a (d) cook.	52		
26	A (b) machinist uses power driven tools to cut, shape, and finish metal parts for machines.	49		
27	Combination welders use math to (a) set and read gas pressure gauges.		48	
28	An example of the kind of work a sheet-metal worker does is (a) install and repair heating systems.	47		
29	Sales clerks use math to (c) figure mark-downs.		46	
30	To be a welder, you should take classes in (c) blueprint reading and drafting.			42

TABLE 15 (Cont.)

Rank	Item	Obj. 1	Obj. 2	Obj. 3
31	Nurse aides and assistants are usually (a) trained on the job.			39
32	A person who is a (d) machinist is likely to have completed an apprenticeship program.			34
	Grand Mean (all items)	68	58	47

Table 16 displays the test results by occupational content areas. Students do seem to have the greatest understanding of information about cooks and the least about machinists. Fewer than fifty percent of the students got higher than 69 percent of the items correct on the other six occupational areas.

The discussion, thus far, has been about the test performance of the entire sample. The next section presents the results of the analysis of differences between groups.

TABLE 16

Posttest Results by Occupational Areas
(Cognitive Items)

Occupation	No. of Items	Mean Percent for Entire Sample
Cook	5	77
Secretary/Clerk Typist	4	69
Sales Clerk	4	66
Plumber	4	65
Sheet Metal Worker	3	61
Welder	4	60
Nurse Aide	4	60
Machinist	4	53

Analysis of Posttest Differences between Groups

An analysis of variance was conducted to determine the effect of participation in the Math on the Job curriculum units on posttest scores for affective and cognitive items. The dependent measures included a total affective score for all 10 affective items and a total cognitive score for all 32 cognitive items. There were also subscores for the two affective learning objectives (5 items each) and for the three cognitive learning objectives (19, 8, and 5 items, respectively).

The analysis focused on two primary sources of variance: 1) the difference between program and control groups and 2) the differences among school districts. The interaction between groups and districts was analyzed also as well as the effects of sex and type of handicap. Table 17 presents the summary of the findings.

Finding 1: There were no significant differences on any of the affective measures.

The total affective scores for the program and control groups were virtually the same (see Table 18). For affective objective 1, the control group scored slightly higher. For affective objective 2, the program group scored slightly higher. Neither of these differences was statistically significant. The differences among districts also were not statistically significant, although district 3 (St. Louis) tended to have slightly lower scores. The affective scores by sex and type of handicap were not significant either.

TABLE 17

Posttest Summary: Analyses of Covariance

Analysis	Source of Variance	Dependent (Criterion) Variables	Multivariate F-Value (Across Dependent Variable)	Relate Univariate F-Values
(A) Total Affective Cooperative Scores	Regression (Covariates-Sex & Type of Handicap)	Affective	1.40	(Mult.R=.26) 2.24
		Cognitive		(Mult.R=.23 1.80
	Districts	Affective	4.93**	1.40
		Cognitive		9.01**
	Groups (Control(1) vs. Program(2)	Affective	2.79	.00
		Cognitive		4.46*
	Interaction (Districts x Groups)	Affective	.69	1.09
		Cognitive		.75
(B) Objective Level Scores	Regression (Covariates-Sex & Type of Handicap)	Affec. Objec. 1	1.50	(Mult.R=.18) 1.03
		Affec. Objec. 2		(Mult.R=.27) 2.51
		Cogni. Objec. 1		(Mult.R=.13) .55
		Cogni. Objec. 2		(Mult.R=.28) 2.73*
		Cogni. Objec. 3		(Mult.R=.31) 3.40*
	Districts	Affec. Objec. 1	3.45**	1.18
		Affec. Objec. 2		1.58
		Cogni. Objec. 1		7.05**
		Cogni. Objec. 2		6.76**
		Cogni. Objec. 3		7.67**
	Groups (Control(1) vx. Program(2)	Affec. Objec. 1	2.18	1.36
		Affec. Objec. 2		1.46
		Cogni. Objec. 1		2.42
		Cogni. Objec. 2		4.55
		Cogni. Objec. 3		2.94
	Interaction (Districts x Groups)	Affec. Objec. 1	.68	1.22
		Affec. Objec. 2		.67
		Cogni. Objec. 1		1.15
		Cogni. Objec. 2		.64
		Cogni. Objec. 3		.17

Note: Levels of significance: *significant at x=.15 level, ** significant at x=.01 level, otherwise, not significant.

Finding 2: The program students scored higher on cognitive measures than the control students.

The mean of the program group was slightly higher than the control group on the total cognitive score. This difference was statistically significant (at the .05 level). Examination of the subscores for cognitive objectives shows that the program group scored higher than the control on all three objectives but the difference was statistically significant (at the .05 level) only for objective 2 (knowledge of use of math on the job). See Table 18 for group means on the cognitive measures.

Finding 3: The differences among the school districts on the cognitive measures were statistically more significant than any other differences.

The differences among districts on the total cognitive measure (all 32 items) was significant at the .01 level. In particular, Milwaukee and Greenville were higher and St. Louis was lower than Salinas (the basis of the comparisons). Similar differences at the .01 level were noted for the subscores on all three cognitive objectives. Milwaukee scored higher than Salinas on objectives 1 and 3. Greenville scored higher than Salinas on objectives 1 and 2. St. Louis scored lower than Salinas on objectives 2 and 3. Thus, the order of performance was Milwaukee, Greenville, Salinas, and St. Louis (see Table 18 for district means).

TABLE 18

Adjusted Posttest Means for Districts and Groups

Analysis	Dependent (Criterion) Variable	Means					
		(1) Districts				(2) Groups	
		Greenville	Milwaukee	St. Louis	Salinas	Control	Program
(A) Total Affective & Comparative Scores	Affective	25.5	25.9	24.3	25.4	25.2	25.3
	Cognitive	22.3	22.8	16.8	17.4	18.7	21.0
(B) Objective Level Scores	Affec. Objec. 1	12.2	12.6	11.9	12.8	12.6	12.2
	Affec. Objec. 2	13.2	13.2	12.3	12.6	12.6	13.1
	Cogni. Objec. 1	14.1	14.7	11.8	10.7	12.3	13.4
	Cogni. Objec. 2	5.5	5.2	3.5	4.3	4.2	5.0
	Cogni. Objec. 3	2.6	2.9	1.5	2.3	2.2	2.5

Finding 4: The emotionally disturbed students scored higher than learning disabled and mentally retarded students on two of the cognitive objectives.

The type of handicap was not related to differences on the total cognitive score. However, it was for two of the three subscores for cognitive objectives. The emotionally disturbed students scored significantly higher (at the .05 level) than the mentally-retarded students on objective 2 (knowledge of the use of math) and objective 3 (knowledge of entry-level requirements). The learning disabled students' score was not significantly higher than the mentally retarded students' score.

Evaluation Results

Program students and teachers completed evaluation forms at the end of the instructional sequence (see appendices I and J). The purpose of these evaluations was to obtain the participants' opinions on the quality of the program.

The student form had five questions related to interest of content, math levels, and to best and least liked booklets. The students rated the booklets as interesting, okay, or boring (44, 30, 26 percent respectively). The majority (68%) indicated that the booklets' information was "about right for me." A majority (80%) also indicated that the math problems were "sort of hard but I figured them out." The Cook and Nurse Aide booklets were most liked. The Sheet Metal booklet was least liked.

The teachers' evaluation form included similar questions as well as questions aimed at improving the program materials.

Fifteen teachers completed the form. The following summarizes the results:

- All but one of the teachers indicated that the materials should be disseminated nationally. However, 86 percent asked for revisions.
- The majority of the teachers (60%) thought the maturity level of the materials to be "just right." The others were about evenly divided on their being too easy or too difficult.
- Most of the teachers liked the "clip art" (73%), but 47 percent also liked the "original" art.
- The majority (60%) thought the vocabulary to be "just right" but 27 percent thought it was "too difficult."
- Teachers rated student-interest level as mediocre; 40 percent, moderate; 20 percent indifferent; and 27 percent low or strongly disliked.
- The majority (67%) rated the instructional value "fair", but 27% rated it good or excellent.
- They rated the organization and presentation of information as mediocre: 53% thought it was good but 47% thought it was fair or poor.
- A large majority (87%) suggested major additions, changes, or deletions that needed to be made.
- The teachers ranked the booklets as follows:

  1. Sales clerks
  2. Cooks
  3. Welders
  4. Nurse Aides
  5. Plumbers
  6. Sheet metal workers
  7. Machinists
  8. Secretaries

- The teachers on average did not rank any section of their favorite booklets as excellent. On a scale where 1 is poor, 2 is good, and 3 is excellent, the mean ratings were--

  2.14 - What training, education, and experience do...need
  2.00 - What do ... need to know
  2.00 - How do ... use math

1.92 - What is it like to be a ...
1.85 - What do ... do
1.85 - Individual simulaton
1.79 - More problems
1.69 - Group simulation

- The teachers rated the materials between average and above average in meeting the affective and cognitive objectives. On a four-point scale where 2 is average. Their mean ratings were:

Objectives	Value to students	Contribution toward Objectives
Affective 1	2.47	2.36
Affective 2	2.53	2.57
Cognitive 1	2.60	2.54
Cognitive 2	2.64	2.75
Cognitive 3	2.53	2.64

Summary

The data from the field test showed program students had greater cognitive learning than control students. However, the differences, though significant, were small. This in addition to the teachers' overall evaluations of the materials as mediocre suggested that the materials would require substantial revision before disseminating them.

PRODUCTION OF FINAL PRODUCT

Revision Process

Drawing upon the many suggested revisions obtained during field site visits and from the evaluation forms, the field-tested materials were extensively revised and reformatted. Detailed guidelines for revising the 30 booklets were developed.

Specific suggestions offered by the teachers to improve the materials are as follows:

- combine the booklet and related materials;
- eliminate the group role play simulation;
- limit the amount of reading;
- break up the amount of reading with activities for students to do;
- include math problems in text;
- provide more math problems;
- provide more difficult and practical math problems; and
- use realistic artwork

Project staff then developed and implemented the following guidelines for the materials.

- Group role plays should be eliminated from materials and recommended as an additional activity in the teachers guide.
- The booklet length should be a maximum of twenty pages.
- Four different occupationally specific math examples should be presented in each booklet.
- Practice math problems should be included in each booklet.
- The artwork should be completely redrawn by a professional artist.

Using the new guidelines, prototype booklets were prepared. Copies of these booklets were sent to each test site and to two independent consultants for a Product Review Evaluation (PRE). In addition, two National Center curriculum developers also reviewed the materials. Minor recommendations were made as a result of the PRE process and, overall, the reviewers found the new prototype to be a vast improvement in the product.

Description and Use of the Final Products

The Math on the Job curriculum series is comprised of 30 booklets and a teacher's guide. Each occupational booklet is designed to focus student attention on a particular job and the basic math skills required to satisfactorily perform that job.

While using the materials, students are given the opportunity to function for a short period of time in a situation that illustrates a real, on-the-job, application of a set of mathematics skills being mastered in the classroom. These materials are supplemental to what is or has been covered in class.

The initial steps involved in the use of these materials is to identify the specific topic being addressed in the classroom and to locate the occupational booklets related to that topic. The teacher may select the most appropriate time(s) to begin working with the material.

The next step involves student selection of a specific booklet corresponding with the occupation that is of most

interest to him/her. If additional practice is necessary and/or a student is interested in other occupations as well, then a second booklet addressing the identified topic may be completed.

Once a specific occupational booklet has been assigned, the student proceeds independently, with teacher assistance provided on an individual, as needed basis. Initially, the student reads background information in the booklet about the occupation and how math is used on the job. Then four job-related math examples are presented. After each example, a series of practice problems is presented for the student to answer. At this time the student can check his/her answers and receive reinforcement if he/she has worked the problems correctly, or the student can proceed with the rest of the booklet.

After completing the first series of math problems, the student reads information about the work environment. At this point, if the student is no longer interested in the occupation or has mastered all the math skills, he/she can proceed to another booklet. If the student is interested in the occupation and/or desires additional practice of the math skills, then the student proceeds with the remainder of the booklet.

The second section of the booklet contains information on the training, education, and experience requirements in order to obtain a job in that occupation. Also, an additional series of math problems is presented. This second set of math

problems corresponds with the first set of problems and builds upon the basic math skills previously reviewed. Outside activities also are suggested. A glossary and answer sheet are included in each booklet.

The teacher's guide presents descriptive information about the materials. Detailed matrixes showing the math competencies introduced in each booklet are provided. Suggestions on how to use the material and other outside activities also are included.

DISSEMINATION

Concerted efforts to disseminate project results and materials have been made. These dissemination efforts represent three major levels: intra-district, regional, and national.

Intra-District Level

To extend and demonstrate the use of materials to additional teachers in the four participating sites, four complete sets of the Math on the Job series have been sent to each site coordinator. This mailing was accompanied by a letter thanking the personnel at each site for their significant contributions to the developmental process. In addition, each site was encouraged to share information about the materials with other teachers in the district. A fact sheet describing the materials (see Appendix K) was included in the mailing to describe the extensively-revised materials.

Regional Level

As the National Center's training arm, the National Academy is in a key position to sponsor regional conferences aimed at introducing educators to the Math on the Job series. Because strong interest in the materials has been received from commercial publishers, actual conduct of conferences to disseminate the product will be planned after a publishing decision is reached. A mock-up generic brochure announcing the regional conferences has been prepared for use by the National Academy and/or the commercial publisher. See Appendix L for a draft version of this brochure.

National Level

Dissemination at the national level has incorporated numerous strategies. First, project staff has submitted proposals to the American Association of Counseling and Development and the American Association for Career Education to present the materials and findings at upcoming annual conventions.

Second, a copy of the final report has been submitted to the Educational Resources Information Center (ERIC) for potential inclusion in the system. Inclusion will assure that information about the report is retrievable by computer and that the report is available on microfiche at 800 locations throughout the world. Third, based on interest expressed by several commercial publishers, a copyright release has been obtained from the project sponsor and the National Center is currently negotiating with the publisher. Pending a final publishing decision, project staff members have prepared the following materials:

- A marketing plan that describes the support role the National Center is prepared to assume with a commercial publisher (see Appendix M).
- A draft news release (see Appendix N).

In the event that commercial publishing arrangements cannot be achieved, the Math on the Job series will be submitted to the National Center's marketing staff for consideration in the cost-recovery program. Once the materials are available for distribution, announcements will be submitted to fifteen national association publication editors.

CONCLUSIONS AND RECOMMENDATIONS

The three-year project was successful in attaining its primary objectives:

1. To prepare a detailed set of content specifications for the proposed materials
2. To develop the instructional materials based upon the designated specifications
3. To empirically evaluate and demonstrate the effects of the devised set of materials in terms of selected student performance criteria
4. To engage in the intra-district, regional, and national dissemination of the project's results and products

Both the pilot and field tests of the instructional materials at four cooperating sites were successful in identifying information useful to refinement and enhancement of the Math on the Job series. The completed series consists of a teacher's guide and a set of 30 booklets designed to reinforce handicapped students' basic math skills and, at the same time, to increase the students' career awareness. Information about what the worker does, where the worker works, how the worker uses math, what things the worker needs to know, and what courses, training, and experience the worker needs to enter the occupation is provided in each booklet. An average of 45 math problems also are incorporated in each booklet.

Initial reactions to the Math on the Job series are exceedingly positive. Several special educators have previewed the materials during their visits to the National Center and are anxious for news of the product's availability. Similarly,

several commercial publishers have expressed interest in the materials.

Based on the total project experience, the following recommendations are made to the project sponsor:

- Basic math skills are essential in order for handicapped students to make the transition from school to work. Given the relative paucity of materials designed for use with handicapped students, additional Math on the Job booklets should be developed.

- In addition to basic math skills, other skills are essential for handicapped students to make the transition from school to work. These skills include communication, reading, writing, and personal-social skills. Curriculum materials should be developed to demonstrate to students how these skills are used by workers on the job.

- Learning disabled, emotionally disturbed, and mentally retarded students have difficulty in applying knowledge learned in a classroom to other areas of their lives. Curriculum units similar to the Math on the Job booklets should be developed to help students learn how basic math skills are used in banking, shopping, selecting housing, and other aspects of everyday life.

- School personnel are faced with the dilemma of teaching career education at the expense of basic skills education. Regional conferences should be held to instruct school personnel on how to infuse career education into basic skills subject areas.

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APPENDIX A

Proposed Forty-four Occupations for Rating by Panel of Special Educators

FORTY-FOUR OCCUPATIONS
PROPOSED TO PANEL FOR RANKING

1. Accounting clerk
2. Architectural technologist
3. Barber/cosmetologist
4. Bookkeeper
5. Carpenter
6. Cashier
7. Combination welder
8. Computer service technician
9. Construction equipment mechanic
10. Construction worker
11. Cook
12. Dietitian
13. Draftsperson
14. Electrician
15. Farmer
16. Heavy equipment operator
17. Insurance salesperson
18. Janitor
19. Legal assistant
20. Linesperson
21. Machinist
22. Maintenance mechanic
23. Maintenance person
24. Meat cutter
25. Medical-laboratory technician
26. Metal-product assembler
27. Motor-vehicle mechanic
28. Nursing aide/assistant
29. Packaging-machine mechanic
30. Painter
31. Plumber
32. Police worker
33. Programmer
34. Radio/TV service person
35. Receiving clerk
36. Respiratory therapy technician
37. Sales clerk
38. Secretary/clerk-typist (stenographer)
39. Sheet-metal worker
40. Surveyor
41. Taxi driver
42. Tractor-trailer driver
43. Truck driver
44. Waiter/waitress

APPENDIX B

Occupational Definitions Booklet

1

ACCOUNTING CLERKS obtain, verify, and post primary financial data for accounting records.

These workers perform routine calculations such as totalling accounts; computing interest charges; determining refunds; and computing freight or express charges and payroll deductions. They may type vouchers, invoices, account statements, payrolls, and accounting reports. Accounting clerks use a variety of math skills such as conversion of percents to decimals and fractions to percents; solving of percentage problems; and calculating of cash discounts. They are responsible for frequent reading, writing, adding, subtracting, multiplying, and dividing of whole numbers, decimals, and fractions as well as for rounding off whole numbers and decimals.

2

ARCHITECTURAL TECHNOLOGISTS assist engineers and other technical workers in the research, design, and development of products, systems, and processes of production.

These workers produce scale drawings, calculate ratio and proportion, fabricate one-of-a-kind components, calibrate equipment, and prepare charts, graphs, and other supporting data for reports. Architectural technologists are able to apply four arithmetic processes; write, simplify, and solve algebraic equations; identify geometric forms; sketch, read, and measure scale drawings; and utilize logarithms to solve architectural or engineering problems.

3

BARBERS/COSMETOLOGISTS provide various hair care and beauty services for customers.

BARBERS cut, shape, shampoo, and blow-dry hair; trim and shape beards and mustaches; fit hair pieces; and record service charges, accept payment, and give change. Barbers must be able to perform computations with whole numbers, decimals, and fractions. They need to estimate time and volume and measure time and quantity. They also need to be able to read, write, and calculate with percents.

COSMETOLOGISTS analyze the condition of hair; shampoo, color, style, cut, press, and set hair; and suggest and apply cosmetics to customers. They record service charges, accept payment, and give change. Cosmetologists must be able to measure volumes of solutions for hair; perform addition, subtraction, multiplication, and division of whole numbers, decimals, and fractions; read, write, and calculate with percents; perform computations using ratios; and measure quantities.

4

BOOKKEEPERS verify, record, and summarize in statistical reports the details of an establishment's financial transactions.

These workers may specialize in such areas as accounts payable, accounts receivable, and investment bonds, or they may maintain an establishment's complete set of financial records, prepare employee payroll checks, and compute, type, and mail statements to customers. Bookkeepers perform computations with whole numbers, decimals, and fractions and may use and/or develop charts and graphs to display data relevant to their work.

5

CARPENTERS erect, install, and repair structures and fixtures of wood, plywood, and wallboard.

These workers use handtools and power tools to perform such tasks as building frameworks, concrete forms, scaffolding, and stairs; installing floors, subfloors, and paneling; and installing prefabricated window frames, doors, doorframes, interior and exterior trim, and finished hardware. Carpenters also assemble materials and fasten them together with nails, dowel pins, and glue; verify the trueness of structures with plumb bobs and levels; and may specialize in a variety of areas, such as rough or finish carpentry. Carpenters' tasks involve many math skills, such as compiling data from various documents to determine amounts of materials to be used; using measuring instruments to prepare layouts and measure materials; determining saw settings for various angle and other saw cuts; performing arithmetical computations involving whole numbers and fractions as well as involving to some degree decimals; solving perimeter problems; identifying geometric forms; estimating distances, areas, and volumes; and measuring distances, time, and quantities.

6

CASHIERS receive and record the amount of payments from customers or employees for goods or services.

These workers compute bills, make change, cash checks, issue receipts, and verify totals shown on a cash register tape against cash on hand. They may be required to know the value and features of items for which money is received, and prepare reports of transactions. Cashiers perform calculations with whole numbers, decimals, and fractions; make change; may need to compute percentage problems; and may be required to solve problems requiring competencies in converting fractions to decimals or percent and decimals to percents or fractions.

7

COMBINATION WELDERS use various welding processes to join metal parts together to make or repair metal products.

These workers use gas welding, brazing, and any combination of arc welding techniques on products such as machine parts, plant equipment, mobile homes, motors, and generators, according to layouts, blueprints, or work orders. Combination welders also set up, operate, and tend machines and equipment to fuse, bond, and cut metals and manipulate and guide welding torches, guns, and other tools along joints and seams at proper rates and angles. Related tasks may include thermal cutting, grinding, repairing of broken or cracked parts, filling of holes, and increasing size of metal parts. Employer performance tests and certification standards of government agencies or professional and technical associations are frequently required for the worker. Competencies in mathematics essential for combination welders include using whole numbers, fractions, and decimals; and using decimal equivalent tables. Use of mathematics also includes reading and interpreting layouts, blueprints, and work orders, as well as making adjustments for production rates and angles (trigonometric functions) in fusion, bonding, and cutting. Ratio and proportion calculation is necessary to determine increasing sizes of parts. Welders must understand and apply basic geometric concepts, apply common English and metric units of measure, read rules, measure angles, analyze and solve welding problems, and calculate waste.

8

COMPUTER SERVICE TECHNICIANS install new equipment and service computers to keep them operating efficiently.

These workers adjust, oil, and clean mechanical and electro-mechanical parts; check electronic equipment for loose connections and defective components or circuits; and find causes of equipment failures and make repairs. Computer service technicians use tools such as voltmeters, ohmmeters, oscilloscopes, an soldering equipment. Computer service technicians require math skills such as reading and writing whole numbers, fractions, and decimals; measuring distances, voltages, time, and amperes; computing resistances through use of algebraic equations; reading, recording, and calculating metric measures; and conversion of fraction to decimal to percent equivalents.

9

CONSTRUCTION-EQUIPMENT MECHANICS analyze malfunctions and repair, rebuild, and maintain construction equipment.

These workers diagnose mechanical defects by operating and inspecting such equipment as cranes, power shovels, paving machines, trench-digging machines, conveyors, bulldozers, and pneumatic tools; use hoists and handtools to dismantle and reassemble the equipment; and examine parts for defective damage or excessive wear using micrometers and gages. Construction-equipment mechanics also replace defective engines and subassemblies, test overhauled equipment to ensure operating efficiency, and weld broken parts and structural members. Construction-equipment mechanics' tasks involve math competencies such as reading, writing, counting, adding, subtracting, multiplying, dividing, and rounding off whole numbers; reading, writing, adding, subtracting, multiplying, dividing, and rounding off decimals; reading meters and gages to examine parts for damage or excessive wear; identifying forms (geometric); measuring with scales and verniers; and reading and interpreting metric measures and gages.

10

CONSTRUCTION LABORERS execute combinations of tasks in erecting, repairing, and wrecking buildings, highways, bridges, tunnels, dams, and water and sewer facilities.

These workers perform tasks such as loading and unloading construction materials and moving the materials among work areas to supply other workers; mixing, pouring, and spreading materials and digging, spreading, and leveling dirt and gravel; and erecting and dismantling scaffolding, protective barriers, and lights. Construction laborers also sort, clean, and pile salvaged materials; remove rubble to clear work areas; and clean and store tools and equipment. Construction laborers' tasks involve math competencies such as measuring distances between grade stakes; reading, writing, counting, adding, and subtracting whole numbers; measuring volumes and quantity; and estimating weight and distance.

11

COOKS prepare and cook foods in various types of establishments.

These workers may clean and prepare ingredients, measure foodstuffs, cook foods according to recipes, requisition needed supplies, and compile information for menus. Cooks use mathematics to compute costs and quantities of foods. They must be able to read, write, compare, and make computations with whole numbers, fractions, and decimals. They must also be able to measure accurately time, weight, distance, quantity, and volume in English and metric systems.

12

DIETITIANS are concerned with applying the principles of nutrition to plan and supervise the preparation and serving of meals.

These workers may set up and supervise food service systems for institutions such as hospitals, restaurants, and schools; provide counseling on nutrition to individuals and groups; and promote sound eating habits through conducting research or instructing in the field of nutrition. Dietitians must be able to compute with whole numbers, fractions, and decimals; perform calculations with percents; convert decimal and percent equivalents of fractions; solve problems relating to ratio, proportion, time, weight, and capacity; read graduated scales; and read and draw graphs. Dietitians may also use mathematics to study, analyze, and report recent scientific discoveries or research in nutrition.

13

DRAFTSPERSONS design and sketch detailed drawings of objects, structures, and systems.

These workers analyze data, ideas, and drawings to determine important factors which should affect their designs. Draftspersons may specialize in areas such as architectural and structural features, automotive design, water and sewage, heating and ventilating, and plumbing. Draftspersons must perform many types of mathematical computations to work out the details of their designs such as add, subtract, multiply, or divide whole numbers, fractions, and decimals; solve for the unknown length of a side of a right triangle; read and write whole numbers, fractions, decimals, and percents; scale drawing dimensions up or down; calculate equivalents of fractions, decimals, and percents; solve ratio, proportion, area, perimeter, and volume problems; identify forms; sketch, read, and measure scale drawings; and estimate distances and areas.

14

ELECTRICIANS install and repair wiring, electrical fixtures, and fuse boxes in various kinds of buildings.

These workers perform such tasks as reading blue prints to determine locations of equipment and conformance to building and safety codes; cutting and connecting wires according to diagrams to install switches, light fixtures, and fuse boxes; and testing circuits and installed equipment to ensure safety and electrical compatibility. Electricians' tasks involve math competencies such as measuring for locations of receptacles and conduits and using such instruments as ohmmeters and oscilloscopes to test the continuity of circuits; reading, writing, counting, adding, subtracting, multiplying, dividing, and rounding off of whole numbers; reading, writing, adding, subtracting, multiplying, and dividing of fractions; reading, writing, adding, subtracting, multiplying, dividing, and rounding off of decimals; reading, writing, and calculating with percents; and measuring time, distance, and quantity.

15

FARMERS operate specialized or general farms on an ownership or contract basis to produce agricultural, horticultural, and animal-husbandry products.

Farmers plan and coordinate farm activities; supervise farm workers in preparation of land, planting, and harvesting crops and breeding and care of livestock; purchase supplies and equipment; keep records of operating costs; and market farm products. Farmers must be able to perform computations with whole numbers, fractions, and decimals. They compute percents and ratios; calculate perimeter, area, and volume; and measure time, weight, distance, and volume. They are able to convert equivalents as fractions to decimals to percents or decimals to percents to fractions.

16

HEAVY-EQUIPMENT OPERATORS operate several types of power construction equipment to excavate, move, and grate earth; erect structural and reinforcing steel; and pour concrete or other hard-surface paving materials.

These workers perform such tasks as adjusting valves to control air and water outputs of machines; driving machines and controlling such attachments as blades, buckets, and scrapers; and repairing and maintaining equipment. Heavy-equipment operators' tasks involve math competencies such as reading, writing, counting, adding, subtracting, multiplying, and dividing whole numbers; estimating of time, weights, volumes, distances, and areas; and measuring time and distances.

17

INSURANCE SALESPERSONS sell life, fire, accident, automobile, and health insurance to individuals and groups.

These workers solicit prospective clients for new business, explain various types of insurance plans to prospective clients, analyze insurance needs of clients, persuade clients to purchase insurance, complete application forms, calculate premiums with given insurance percentage rates, and establish payment methods for clients. Insurance salespersons use mathematics to calculate premiums and read rate books, interpret statistical data in tables, and calculate insurance needs of clients.

18

JANITORS clean building interiors and grounds and make minor repairs on the premises.

These workers perform tasks such as sweeping, mopping, and waxing floors; cleaning windows, washrooms, and furniture; mowing lawns; emptying trash receptacles; performing minor painting and carpentry tasks; and notifying management of the need for major repairs or additions to lighting, heating, and ventilating. Janitors may have to set number dials to operate equipment and perform measurements connected with repair work. They need to read, write, add, subtract, multiply, and divide whole numbers, fractions, and decimals; read and write percents; measure distances and time; compute perimeters, areas, and volumes; estimate time and distance; and read and measure from scale drawings.

19

LEGAL ASSISTANTS research cases of law, investigate facts, and prepare documents to assist lawyers.

These workers may research sources such as statutes and recorded judicial decisions; prepare legal documents such as briefs, appeals, wills, and contracts; appraise and inventory property for estate planning; deliver subpoenas to witnesses; and prepare office accounts and tax returns. Legal assistants may need to perform calculations using whole numbers, fractions, percents, and decimals; compute percentage problems; read and draw graphs and charts; compute areas, perimeters, and volumes; measure time; and perform a variety of other calculations and measurements related to data collection for specific cases.

20

LINESPERSONS install, maintain, and repair power lines and related equipment.

These workers perform such tasks as climbing poles and installing transformers, lightning arresters, switches, and other accessories; stringing and splicing overhead cables and wires; and repairing and replacing defective lines, cables, poles, auxiliary equipment, and hardware to restore power. Linespersons' tasks involve math competencies such as solving problems requiring analysis of test data readings to locate and identify equipment failures and compiling information from specifications or visual observation to determine appropriate work procedures; reading, writing, adding, subtracting, multiplying, dividing, and rounding off whole numbers; reading, writing, adding, subtracting, multiplying, and dividing fractions and decimals; measuring perimeters; estimating time, distance, area, and weights; measuring distance; identifying forms; and reading scale drawings and/or work orders.

21

MACHINISTS use power-driven tools to cut, shape, and finish metal parts for machines.

These workers perform such tasks as setting up and operating lathes, drill presses, shapers, and grinders and analyzing specifications and drawings to determine dimensions and tolerances of pieces to be machined, sequences of operation, and material and equipment required. Machinists also measure, mark, and scribe dimensions and reference points to lay out stock for machining and compare dimensions and other characteristics of finished workpieces to specified requirements. Machinists' tasks involve such math competencies as using whole numbers, fractions, and decimals; reading drawings and work orders and computing necessary dimensions; measuring and laying out workpieces; and using measuring instruments including metric scales to verify dimensions and to ensure adherence to specifications.

22

MAINTENANCE MECHANICS repair and maintain machines and mechanical equipment.

These workers use handtools, power tools, and precision measuring and testing instruments and read and interpret diagrams, sketches, operation manuals, and manufacturers' specifications to work on engines, motors, pneumatic tools, conveyor systems, production machines, and equipment. Maintenance mechanics perform tasks such as locating causes of trouble; dismantling devices to gain access to and remove and repair or replace defective parts; installing special functional and structural parts; and lubricating and cleaning parts. Maintenance mechanics' tasks involve math competencies such as using rulers, calipers, micrometers, and other measuring instruments to detect changes in dimensional requirements of used parts.

23

MAINTENANCE PERSONS repair and maintain the physical structures of commercial and industrial establishments.

These workers use hand and power tools in factories, office buildings, and apartment and town houses, to perform tasks such as repairing defective electrical switches, painting structures and repairing woodwork, and repairing and adjusting doors and windows. Maintenance persons also repair minor faults in plumbing, repair plaster and lay brick or cement blocks, and mix and pour cement to construct cement forms. Maintenance persons' tasks involve math competencies such as reading, writing, adding, subtracting, multiplying, dividing, and rounding off whole numbers; reading percents; determining areas and perimeters; and estimating volumes, distances, and areas.

24

MEAT CUTTERS use handtools and power equipment to cut and trim meats to size for display or as ordered by customers.

These workers perform such tasks as cleaning and cutting meat, fish, and poultry; tending meat-processing equipment such as grinders, cubing machines, and sausage makers; and shaping, lacing, and tying meat cuts by hand. Meat cutters' tasks involve math competencies such as estimating weights; weighing cuts of meat; setting power equipment per scale for cutting and trimming; reading weight scales; and collecting money for sales (includes reading, writing, counting, adding, subtracting, multiplying, and dividing whole numbers, fractions, decimals, percents, and equivalents).

25

MEDICAL LABORATORY TECHNICIANS perform routine tests in medical laboratories for use in the treatment and diagnosis of disease.

These workers may take blood samples, prepare tissue samples, execute urinalyses and blood counts, and make quantitative and qualitative chemical and biological analyses of body specimens under the supervision of the laboratory director or medical technologist. Medical laboratory technicians prepare and interpret graphs, perform metric liquid measure, and utilize varied arithmetic skills to perform their work, including reading, writing, adding, subtracting, multiplying, and dividing whole numbers, fractions, and decimals; reading and writing percents; performing fraction, decimal, and percent equivalent conversions; estimating and measuring volumes and weights; and utilizing metric systems in calculations.

26

METAL-PRODUCT ASSEMBLERS put together products such as vacuum cleaners, valves, hydraulic cylinders, and domestic appliances.

These workers are stationed at benches or on shop floors to perform tasks such as positioning component parts according to knowledge of the unit being assembled or in accordance with drawings and specifications; aligning holes and using hand and portable power tools to assemble parts with bolts, screws, rivets, and other fasteners; and filing and scrapping parts to produce close fits. Product assemblers' tasks involve math competencies such as comparing spatial relationships; reading, interpreting, and describing drawings and specifications; reading and recognizing dimensions and size of parts for fitting; and using whole numbers, fractions, and decimals, including metric measures.

27

MOTOR-VEHICLE MECHANICS repair and overhaul automobiles, buses, trucks, and other automotive vehicles.

These workers perform tasks such as examining vehicles and explaining the nature and extent of any damage or malfunction; using charts, technical manuals, and experience to plan work procedures; and using hydraulic jacks or hoists, wrenches, and mechanics' handtools to position vehicles, remove and disassemble various parts, and repair and replace parts. Motor-vehicle mechanics' tasks involve math competencies such as using whole numbers, fractions, decimals, percentages, ratios, proportions, and the metric system; reading micrometers, rules, calipers, and thickness gages; making time and distance estimates; estimating costs; and following simple to complex instructions.

28

NURSING AIDES/ASSISTANTS provide care to patients in hospitals, clinics, and nursing homes.

These workers attend to personal needs of patients; set up equipment; lift patients; take and record temperatures, pulse, and respiration rates; measure and record food and liquid intake and output; and clean, sterilize, and store treatment trays, instruments, and other supplies. Nursing aides/assistants must be able to say, read, write, and compare whole numbers, fractions, and decimals to measure and chart patients' behavior.

29

PACKAGING-MACHINE MECHANICS repair, adjust, and maintain machines and equipment that package products like food and drugs.

These workers perform such tasks as installing various mechanisms (e.g., capping and sealing units and product-feed hoses) on equipment and adjusting these and such other mechanisms as guides, jigs, and speeds of conveyors and transfer mechanisms to accommodate package dimensions and specified production volumes; diagnosing and locating causes of machine malfunction by observing machines in operation; and using handtools to dismantle machines for cleaning, lubricating, and repairing them. Packaging-machine mechanics' tasks involve math competencies such as reading, writing, counting, adding, subtracting, multiplying, dividing, and rounding off whole numbers; reading, writing, adding, subtracting, multiplying, dividing, and rounding off decimals; solving problems related to adjusting speeds and volume accommodations of conveyors of packages of different sizes and shapes; reading work order specifications; identifying forms; and reading scale drawings.

30

PAINTERS brush or spray paint and related materials on interior or exterior surfaces of buildings and other structures.

These workers use handtools and solvents to clean and prepare surfaces, mix paints, coat surfaces, and clean and maintain equipment. Painters' tasks involve math competencies such as estimating areas, volumes, materials needed, and costs. They must be able to read and write measurements; make calculations using addition, subtraction, multiplication, and division with whole numbers, fractions, and decimals; and solve problems involving ratios, proportions and percents.

31

PLUMBERS assemble, install, and repair pipes, fittings, and fixtures of heating, water, and drainage systems.

These workers use hand and power tools to cut, thread, solder, and caulk various types of pipes and fittings and to cut openings in structures to accommodate piping. Plumbers also assemble and install valves, pipe fittings, pipes, and such plumbing fixtures as sinks, commodes, hot water tanks, etc., and repair and maintain plumbing by replacing washers in leaky faucets, repairing burst pipes, and opening clogged drains. Plumbers' tasks involve math competencies such as measuring lengths and diameters of pipes and fittings; compiling information from various sources to solve problems of determining amounts of materials, equipment, and labor needed; and estimating and figuring customers' bills. Specific mathematics competencies include reading and writing whole numbers, fractions, decimals, and percents; adding, subtracting, multiplying, and dividing whole numbers, fractions, and decimals; calculating percents and converting fractions to decimals to percents; identifying geometric forms; and reading work orders.

32

POLICE WORKERS are concerned with protecting the public, maintaining law and order, preventing crime, directing traffic and conducting investigations of accidents and crimes.

These workers arrest violators, investigate complaints, locate missing persons, give evidence in court, issue traffic tickets, and write daily activity reports. Police workers must be able to compare and perform arithmetic operations with whole numbers, decimals, and fractions and estimate and measure distance, height, weight, and time.

33

PROGRAMMERS convert business, scientific, engineering, and other technical problem formulations to program formats which can be processed by computer.

These workers write detailed logical flow charts and block diagrams; encode equations for processing by applying knowledge of advanced mathematics; confer with clients and technical personnel to resolve problems of intent, inaccuracy, or feasibility of computer processing; and review results of computer runs. Programmers use a variety of mathematical processes in their work including solving problems using whole numbers, fractions, and decimals; reading and preparing graphs and charts; and performing numerical analyses.

34

RADIO AND TV SERVICEPERSONS use handtools and electronic testing instruments to repair and adjust radios and television receivers.

These workers perform tasks such as tuning receivers and observing audio and video characteristics to locate sources of trouble; adjusting controls and testing and changing tubes; and using voltmeters, oscilloscopes, signal generators, and other electronic instruments to test voltages and resistances of circuits to isolate defects. Radio and TV servicepersons' tasks involve math competencies such as reading, writing, adding, subtracting, multiplying, and dividing of whole numbers, fractions, decimals and percents; rounding off whole numbers and decimals; calculating percents; equivalence conversion of decimals, fractions and percents; applications to verbal problems; reading of scale drawings and graphs; and measuring with scales and vernier calibrations.

35

RECEIVING CLERKS are concerned with verifying and keeping records on incoming shipments.

These workers receive, unpack, sort, verify, and record data about items coming in to verify descriptions against bills of lading and other records. They reject damaged items, record shortages, route items to departments, and correspond with shippers to rectify problems. Receiving clerks use arithmetic and measurement skills including reading numerical records; counting, weighing, and measuring items to verify their quality and characteristics; and reading, writing, adding, subtracting, multiplying, and dividing whole numbers, fractions, and decimals. They may need to convert fractions to decimals, decimals to percents, and/or combinations.

36

RESPIRATORY THERAPY TECHNICIANS, following doctors' orders, treat patients with cardio-respiratory problems.

These workers set up and operate devices such as respirators and mechanical ventilators; assist patients in performing breathing exercises; monitor patients' physiological responses to therapy; and inspect, assemble, and operate equipment used. Respiratory therapy technicians must be able to read graduated scales; compute with whole numbers, fractions, and decimals; solve problems relating to weight, time, and capacity; and read and draw graphs.

37

SALES CLERKS sell commodities, about which they may or may not have expert knowledge, usually in retail trade establishments.

These workers serve customers by writing sales slips for items purchased; receiving payment or preparing charge slips; and making change and wrapping or packing customers' purchases. They may also stock shelves with merchandise, maintain records of sales and inventory, and order replacement merchandise. Sales clerks use mathematics to total bills, read tax charts, compare prices and merchandise identification numbers, make change, and calculate sales discounts. Major computations require competencies in reading, writing, adding, subtracting, multiplying, and dividing whole numbers, decimals, and fractions. They need also to read, write, and calculate with percents.

38

SECRETARIES handle correspondence and perform routine and detail work for a person or group of persons with higher rank.

These workers type, take dictation, read and route incoming mail, file, answer the telephone, schedule appointments, order office supplies, and greet visitors. Secretaries use decimals in financial transactions; whole numbers, fractions, and decimals in typing; time measurement; and weight measurement in preparing outgoing mail.

39

SHEET-METAL WORKERS make, assemble, install, and repair sheet-metal products.

These workers follow job orders and blueprints to compile and analyze information to determine specifications and procedures relating to their work with control boxes, drainpipes, air ducts, appliance cabinets, and furnace casings. Sheet-metal workers also use hand and power tools to cut, bend, straighten, and shape metal and to weld parts and smooth seams and surfaces. Sheet-metal workers' tasks involve such math competencies as preparing bids and estimates; reading and interpreting job orders and blueprints which may include linear and trigonometric measurements; and using measuring instruments to determine, record, and describe quantities, sizes, and shapes of articles to be made.

40

SURVEYORS plan, organize, and direct the work of survey parties engaged in marine, land, and subsurface surveys.

These workers establish and describe official boundaries; determine the precise location of natural and constructed features in the survey project area; and prepare sketches, maps, and reports using the data collected in a survey. Surveyors must perform many types of mathematical computations in their work, including add, subtract, multiply, and divide whole numbers, fractions, and decimals; perform calculations with percents; convert equivalents of fractions, decimals, and percents; solve problems relating to ratio, proportion, areas, perimeters, and volumes; draw to scale; perform measurements of weight, distance, and capacity; and use trigonometric logarithms.

41

TAXI DRIVERS operate taxicabs to transport passengers for fees.

These workers perform tasks such as picking up passengers in response to requests for services from dispatchers or when hailed; handling luggage and assisting passengers boarding and leaving vehicles; collecting fees recorded on taximeters based on mileage and time; and recording transactions in logs. Taxi drivers' tasks involve math competencies such as making change; writing receipts; estimating and calculating fare charges, including gratuities; and estimating time and distances.

42

TRACTOR-TRAILER DRIVERS operate gasoline or diesel-powered tractor-trailor combinations, usually over long distances, to transport and deliver goods and materials.

These workers perform tasks such as using knowledge of commercial driving regulations and special skills and techniques to maneuver vehicles in difficult situations; inspecting trucks before and after trips and submitting reports on truck conditions; and connecting and disconnecting airlines and hoses and operating jack supports. These truck drivers' tasks involve math competencies such as maintaining logs according to I.C.C. regulations; reading and writing whole numbers, fractions, and decimals; performing four arithmetical processes; determining fraction, decimal, and percent equivalents; measuring volumes and distances; and estimating time, weight, volume, and quantity.

43

TRUCK DRIVERS WHO MAKE LOCAL DELIVERIES operate light trucks to transport goods and materials.

These workers drive trucks with capacities under three tons and perform tasks such as arranging delivery routes according to deliveries and calls to to be made, ensuring that loads are placed in trucks in ways that minimize amounts of time required to locate parcels, inspecting truck equipment and supplies, and performing emergency roadside repairs. These truck drivers' tasks involve math competencies such as verifying loads against shipping papers, collecting payments for goods delivered and for delivery charges; and maintaining truck logs according to state and federal regulations. Specific mathematics competencies include reading and writing of whole numbers, fractions, and decimals; performing four arithmetic operations of addition, subtraction, multiplication, and division; and estimating weights, volumes, time, and distances.

WAITERS AND WAITRESSES serve food and beverages in public places.

These workers may set places, write food orders, answer questions about items on the menu, make up itemized checks, accept payment, and make change. Waiters and waitresses must be able to read, write, add, subtract, multiply, and divide whole numbers, fractions, and decimals. They may need to be able to calculate with percents.

APPENDIX C

Occupational Tasks and Related
Math Skills for Thirty Occupations

ACCOUNT CLERKS

Occupational Task	Related Math
Compile data for financial statements.	Read, write, say, compare, add, subtract, multiply, and divide with whole numbers, fractions and decimals.
Verify accuracy of records.	Compare and perform computations with whole numbers, fractions, and decimals.
Compute figures for accounts.	Compute credit for partial payment; estimate to assess the reasonableness of a result to a calculation.
Post entries on ledgers.	Write whole numbers, fractions, and decimals. Compare numbers.
Prepare invoices.	Same as above. Compute interest.
Communicate information about accounts.	Read, write, and say whole numbers, fractions, and decimals.
Balance financial records.	Make computations with decimals. Compare decimals. Estimate.
Prepare reports.	Develop charts. Perform computations with whole numbers, fractions, and decimals. Compute percentage. Determine measures of central tendency. Estimate.
Type vouchers, invoices, account statements, payrolls, reports, etc..	Read and compare (proofread) whole numbers, decimals, and fractions.

ACCOUNT CLERKS--continued

Occupational Task	Related Math
Prepare payroll.	Add, subtract, multiply, and divide with whole numbers and decimals; read charts; calculate payroll deductions; and solve percentage problems. May need to understand computer capabilities, and use computer terminals for data entry and data output.

BARBERS

Occupational Task	Related Math
Style and cut hair.	Estimate length.
Shape hair.	
Shampoo hair.	
Trim and shape beards/mustaches.	Estimate length.
Fit hair pieces.	Estimate and measure.
Apply lotions, dyes, etc.	Measure time. Measure liquids.
Manipulate clippers, comb, scissors, and blow-out gun.	
Record service charges.	Write decimals.
Accept payment and give change.	Recognize denominations. Compare two decimals. Count correct change from amount due to amount tendered.

BOOKKEEPERS

Occupational Task	Related Math
Prepare employee payroll checks.	Add, subtract, multilpy, and divide with whole numbers and decimals; solve percentage problems; and calculate payroll deductions. Calculate gross hourly wages of hourly paid workers. May maintain records of employees' use of sick and annual leave time. May need to understand computer capabilities and use computer terminals for data entry and data output.
Compute customers' statements.	Add, subtract, multiply, and divide with decimals.
Type customers' statements, etc.	Proofread numbers.
Verify data.	Compare two numbers.
Record data.	Write and proofread numbers.
Summarize data.	Use estimation to determine reasonableness of a result to a calculation.
Write reports (e.g., withholding, social security, and tax reports).	Perform computations with whole numbers, decimals, and fractions; solve percentage problems; calculate payroll for various time periods; calculate profits; use and develop charts and graphs to display data, e.g., changing conditions in business.
May calculate inventory and reorder point.	Compute with whole numbers, decimals, and fractions. Estimate and measure time.
Use calculator.	

CARPENTERS

Occupational Task	Related Math
Lay out and mark measurements on materials from blueprints, drawings, or samples.	Find distance around basic geometric figures; understand the concepts: point, line, plane, parallel, perpendicular, and angle; determine accuracy of measurements; determine area of basic geometric figures; scale something up or down; convert units of measurement; add and subtract angles; determine which of two fractions/decimals is greater; determine which of two measurements is more precise.
Build frameworks, concrete forms, scaffolding, and stairs.	Estimate the amount of roof boards to order given the area and percent waste; calculate board feet; determine amounts of materials to be used; measure distance, time, quantity, weight, capacity, and temperature.
Build frame and install roof.	Determine roof pitch given the run and rise; calculate number of squares required to cover a roof given pitch, span, bridge length, and shingle exposure.
Install paneling/partitions, doors, prefabricated window frames, and interior/exterior trim.	
Fasten materials together.	
Use measuring instruments.	
Cut and shape materials.	Determine saw settings for various angles and other cuts.

CARPENTERS--continued

Occupational Task	Related Math
Select materials to be used.	Determine amounts of materials to be used.
Lay out and install cabinet work.	
Install floors.	Estimate the number of floor joists required for a certain building. Perform numeric operations with signed numbers (+ or -). Perform algebraic addition, subtraction, multiplication, and division. Solve simple algebraic equations with one unknown (3X = 6, for X). Know strategies of problem solving.

CASHIERS

Occupational Task	Related Math
Greet customers.	Give directions using numbers; estimate and measure time.
Receive payments.	Recognize value of check or money.
Record payments.	Write decimals.
Compute balance due.	Add, subtract, multiply, and divide with decimals.
Make change.	Compare decimals. Count from amount due on bill to amount tendered. Count by 5s, 10s, etc.
Cash checks.	Count (desired) denominations of paper and coins, up to total amount of check.
Issue receipts.	Write decimals.
Verify totals shown on a cash register tape against cash on hand.	Add, subtract, multiply, and divide with decimals. Count cash on hand. Compare two decimals.
Answer questions about items sold (value of, features, etc.).	Count items. Estimate weight.
Prepare reports or summaries of transactions.	Add, subtract, multiply, and divide with decimals, whole numbers, and fractions. Compute percentage. Proofread numbers.
Complete credit card transactions.	Write whole numbers and decimals.
List cash and checks for bank deposit.	Write decimals.

CASHIERS--continued

Occupational Task	Related Math
Total cash and checks for bank deposit.	Add decimals.
Prepare bank deposit slip.	Write decimals.
Package merchandise appropriately.	Estimate volume

COMBINATION WELDERS

Occupational Task	Related Math
Read work orders, blueprints, and layouts.	Read a rule. Measure from scale drawings.
Set up machines and equipment to fuse, bond, and cut metals.	Given two measurements determine which is more precise.
Operate machines and equipment to fuse, bond, and cut metals.	Use common English and metric units of measure (length, weight, volume, temperature, time).
Operate equipment to manipulate and guide welding torches, guns, and other tools along joints and seams at proper rates and angles.	Understand the basic geometric concepts of point, line, plane, parallel, perpendicular, and angles. Add and subtract angles. Measure angles. Use a square for direct or indirect measurement. Understand the properties of basic geometric figures.
Determine the most economical layout.	
Calculate waste.	
Find the bend allowance.	
Estimate the cost to complete a job.	Add, subtract, multiply, and divide with whole numbers, fractions, and decimals. Estimate time.

CONSTRUCTION LABORERS

Occupational Task	Related Math
Load and unload construction materials.	Estimate weight; read, write, count, add, and subtract whole numbers; measure quantity.
Move materials among work areas to supply other workers.	Estimate weight and distance.
Mix, pour, and spread materials.	Measure volumes and quantity
Dig, spread, and level dirt and gravel.	
Erect and dismantle scaffolding, protective barriers, and lights.	Estimate and measure length. Estimate distance.
Sort, clean, and pile salvaged materials.	
Remove rubble to clear work areas.	
Clean and store tools and equipment.	

COOKS

Occupational Task	Related Math
Clean and prepare ingredients.	Count and estimate amounts and sizes.
Measure foodstuffs.	Read, write, compare, and make computations with whole numbers, fractions, and decimals. Measure weight, quantity, and volume in English and metric systems.
Cook foods according to recipes.	Read and carry out instructions in written recipes. Estimate and measure weight, quantity, volume, and time. Compare, add, subtract, multiply, and divide whole numbers, fractions, and decimals to increase or decrease recipe specifications. Regulate temperature gauge on ovens and other devices used to cook foods.
Requisition needed supplies.	Read, write, say, add, subtract, multiply, and divide with whole numbers, fractions and decimals. Estimate supply use for specified periods of time.
Compile information for menus.	Estimate and calculate time and labor costs of preparing various orders; estimate and calculate costs of ingredients in various orders.

COSMETOLOGISTS

Occupational Task	Related Math
Analyze the condition of hair.	Read, write, say, add, and subtract whole numbers and fractions. Read and apply instructions on hair color use, including measurement of time and volume, and use of ratio.
Color hair.	
Shampoo hair.	
Style, press, and set hair.	
Cut hair.	Estimate and measure length.
Suggest hair care products to customers.	Read and understand product use instructions. Read, write, say, add, and subtract whole numbers and fractions.
Suggest cosmetics to customers.	
Apply cosmetics to customers.	
Accept payment.	Recognize denominations of money. Know which of two numbers is larger (or smaller).
Record service charges.	Write decimals.
Give change.	Add, subtract, multiply, and divide decimals. May have to read a tax chart. Count from amount due to amount tendered.

ELECTRICIANS

Occupational Task	Related Math
Plan layout of wiring, electrical fixtures and control equipment.	Perform numeric operations with whole numbers, fractions and decimals. Estimate results of numeric operations before solving problems.
Plan new or modified installations to minimize waste of materials, provide access for future maintenance, and avoid unsightly, hazardous, and unreliable wiring, consistent with specifications and local electrical codes.	Calculate the impedance of a circuit given its resistance and reactance, calculate load voltage given supply voltage and maximum voltage drop percent. Perform numeric operations with signed number (+ or -). Compute the resistance of 800 feet of wire if 200 feet of the same wire has a resistance of 4 ohms. Calculate the resistance of wires of any diameter, any length, or any material. Solve simple algebraic equations with one unknown. Calculte the total resistance in a parallel circuit. Calculate VA given watts and power factor (PF). Calculate the line voltage in a wye-connection, three phase circuit given the phase voltage.
Prepare sketches showing location of wiring and equipment or follow diagrams or blueprints, insuring that concealed wiring is installed before completion of future walls, ceilings, and flooring.	Measure with tape measure. Measure from scale drawings. Understand properties of right triangles. Find the area of basic geometric figures.
Connect power cables to equipment, such as electric range or motor, and install grounding leads.	Calculate the power input of a motor given its output and efficiency.

ELECTRICIANS (continued)

Occupational Task	Related Math
Test continuity of circuit to insure electrical compatibility and safety of componants, using testing instruments, such as ohmmeter, battery and buzzer, and oscilloscope.	
Observe functioning of installed equipment or system to detect hazards and need for adjustments, relocation, or replacement.	Calculate load voltage given supply voltage and maximum voltage drop percent.
Repair faulty equipment or systems.	Same as planning new or modified installations.
May cut and weld steel structural members, using flame cutting and welding equipment.	
Measure, cut, bend, thread, assemble and install electrical conduit using tools, such as hacksaw, pipe threader, and conduit bender.	
Pull wiring through conduit.	
Splice wires by stripping insulation from terminal leads with knife or pliers, twisting or soldering wires together, and applying tape or terminal caps.	
Connect wiring to lighting fixtures and power equipment, using hand tools.	
Install control and distribution apparatus, such as switches, relays, and circuit-breaker panels, fastening in place with screws or bolts, using hand tools and power tools.	

HEAVY EQUIPMENT OPERATORS

Occupational Task	Related Math
Adjust valves to control air and water outputs of machines.	Read, write, say and perform computations with whole numbers. Read and adjust graduated scales.
Adjust handwheels and depress pedals to drive machines such as cranes, tractors, motor graders, bulldozers, dredges, draglines, and power-shovels.	
Control attachments such as blades, buckets, and scrapers.	
Excavate, move, and grade earth.	Estimate weight, time, volume, area, and distance. Read from scale drawings. Measure time and distance.
Pour concrete or other hard surface paving materials.	Estimate and measure volume. Measure weight, distance, and area.

LOCAL TRUCK DRIVERS

Occupational Task	Related Math
Operate a light truck (under 3 tons) to transport materials.	Read graduated scales. Maintain truck log according to state and federal regulations.
Arrange delivery route according to deliveries and calls to be made.	Estimate time and distance.
Assure that loads are placed in truck in ways that minimize amounts of time required to locate parcels or goods.	Verify loads against shipping papers. Read and write whole numbers, fractions, and decimals. Add, subtract, multiply, and divide with whole numbers.
Inspect truck equipment and supplies.	
Perform emergency roadside repairs.	
May collect payment for goods delivered.	Compare two amounts. make change.
Record deliveries and sales.	

MACHINISTS

Occupational Task	Related Math
Set up and operate machine tools.	
Fit and assemble parts to make or repair metal parts, mechanisms, tools, or machines, applying knowledge of mechanics, shop mathematics, metal properties, and layout and machining procedures.	Solve cutting speed, rpm, and cutting time problems by substitution in given formulas. Solve production time, and cutting feed problems by rearranging and combining formulas. Identify the gear formula to use to solve gear problems depending on the unknown and given data.
Study specifications, such as blueprint, sketch, damaged part, or description of part to be replaced, to determine dimensions and tolerances of piece to be machined, sequence of operations, and tools, materials, and machines required.	Convert a measurement given in fractional form to decimal form, and vice versa. Use tables of decimal equivalents. Identify different types of angles. Add, subtract, multiply, and divide angles in terms of degrees, minutes, and seconds. Measure angles with a simple protractor. Identify parts of a circle. Solve problems by using geometric principles which involve chords, arcs, central angles, perpendiculars, and tangents. Find the distance around a circle, rectangle, or triangle. Scale a measurement up or down.
Measure, mark, and scribe dimensions and reference points to lay out stock for machining.	Use calibrated ruler, micrometer, caliper, and scriber. Add, subtract, multiply and divide using whole numbers, fractions, and decimals. Make decimal measurements to a specific level of accuracy. Round a measurement to a given place value. Use different degrees of decimal precision for representing a measurement.
May develop specifications from general description and draw or sketch product to be made.	

Occupational Task	Related Math
Set up and operate metal-removing machines, such as lathe, milling machine, shaper, or grinder, to machine parts to specifications.	
Verify conformance of workpiece to specifications, using measuring instruments.	See measurement skills listed above.
Position and secure workpiece in holding device, such as chuck or collet, or on surface place or worktable with such devices as vises, V-blocks, and angle plates.	
	Work with tolerances and limits.
	Select gauge block combinations.
Use handtools, such as files, scrapers, and wrenches, to fit and assemble parts to assemblies or mechanisms.	
Verify dimensions and alignment with measuring instruments, such as micrometers, height gages, and gage blocks.	See measurement skills listed above.
May operate mechanism, or observe operation, or test with inspection equipment to diagnose malfunction of machine or to test repaired machine.	
May perform flame cutting and arc or gas welding operations.	
Layout and drill equally spaced holes on a circle.	

MAINTENANCE MECHANICS

Occupational Task	Related Math
Repair machinery and mechanical equipment, such as engines, motors, pneumatic tools, conveyor systems, and production machines and equipment.	Read diagrams and sketches. Read and interpret operation manuals, including numerals and various measurements. Use precision-measuring and testing instruments. Given two measurements, determine which is the more precise.
Maintain machinery and mechanical equipment.	Solve ratio problems (gear ratio, compression ratio, differential ratio, air-fuel ratio). Solve a proportion problem (gear trains, gear reduction).
Observe mechanical devices in operation and listen to their sounds to locate causes of trouble.	
Dismantle devices to gain access to and remove defective parts, using hoists, cranes, handtools, and power tools.	Read diagrams and sketches.
Examine form and texture of parts to detect imperfections.	Use precision-measuring and testing instruments.
Inspect used parts to determine changes in dimensional requirements.	Use rules, calipers, micrometers and other measuring instruments. Use common English and metric units of measure (length, weight, volume, temperature, time). Read fractional divisions on a steel tape. Say, read, write, add, subtract, multiply, and divide whole numbers, fractions, and decimals.
Adjust functional parts of devices and control instruments, using handtools, levels, plumb bobs, and straightedges.	Convert fractions to decimals and vice versa.

MAINTENANCE MECHANICS--continued

Occupational Task	Related Math
Install special functional and structural parts in devices, using handtools.	
Start devices to test their performance.	
Lubricate and clean parts.	
May set up and operate lathe, drill press, grinder, and other metal working tools to make and repair parts.	
May initiate purchase order for parts and machines.	Say, read, write, add, subtract, multiply, and divide whole numbers, fractions, and decimals. Compare two numbers. Accurately record numeric code numbers for parts.
May repair electrical equipment.	

MEAT CUTTERS

Occupational Task	Related Math
Cut and trim meat to size for display or as ordered by customers using hand tools and power equipment, such as grinder, cubing machine, and power saw.	Estimate and measure cuts by weight. Add, subtract, multiply, and divide with whole numbers, fractions and decimals. Read graduated scales.
Clean and cut fish and poultry.	
Shape, lace, and tie meat cuts by hand using boning knife, skewer, and twine to form roasts.	
May place meat in containers or on trays.	
May weigh, price, and wrap meat for customers.	Estimate weight of meat and weigh meat. Calculate price per pound or read scale showing price per pound. Use estimation to determine the reasonableness of a result to a calculation.
May inspect and grade meats.	
May collect money for sales.	Read, write, say, and perform computations with whole numbers, fractions, and decimals. Make change.

METAL PRODUCT ASSEMBLERS

Occupational Task	Related Math
Position component parts according to knowledge of the unit being assembled or in accordance with drawings and specifications.	Compare spatial relationships. Read, interpret, and describe drawings and specifications. Read and recognize dimensions and size of parts for fitting. Use whole numbers, fractions, and decimals, including metric measures.
Align holes and use hand and portable power tools to assemble parts with bolts, screws, rivets, and other fasteners.	
File and scrape parts to produce close fits.	
May operate drill presses, punch presses, or riveting machines to assist in assembly operation.	
May dissassemble power brake boosters, airbrake compressors, and valves for salvage of parts.	

MOTOR VEHICLE MECHANICS

Occupational Task	Related Math
Examine vehicle to identify nature and extent of repairs needed.	Know the strategies of problem solving.
Discuss with operator and/or foreman the nature and extent of repairs required.	Read, write, and say whole numbers, fractions, and decimals. Estimate time, length, weight, volume, and temperature.
Plan work procedures using manufacturers' charts, technical manuals, and experiences.	Say, read, and write whole numbers, fractions and decimals. Know strategies of problem solving.
Locate malfunctions, using test equipment such as timing lights, electrical meters, and analyzers.	Read graduated scales. Say, read and write decimals. Read fractional divisions on a steel tape. Add and subtract decimals. Round off whole numbers and decimals. Read a micrometer. Use metric conversion.
Adjust malfunctioning part(s) to specification.	Lay out and drill equally spaced holes. Solve ratio problems (gear ratio, compression ratio, differential ratio, air-fuel ratio). Solve a proportion problem (gear trains, gear reduction).
Raise vehicle using hydraulic jack or hoist to gain access to mechanical assemblies bolted to underside of vehicle.	
Remove and dissassemble various parts.	
Repair and replace parts.	Use common English and metric units of measure (length, weight, volume, temperature, time). Read a rule. Use precision properly and given two measurements determine which is the most precise.

MOTOR VEHICLE MECHANICS (continued)

Occupational Task	Related Math
May prepare estimate of costs for customer (material and labor).	Read, write, say, and perform computations with whole numbers and decimals.
May prepare bill for parts and service.	Same as above. Calculate discount and sales taxes.

PAINTERS

Occupational Task	Related Math
Brush paint, lacquer, rust-proofing or other coating onto specified surface.	
Clean surfaces, using hand scraper, wire brush, sandpaper, or turpentine.	
Pour desired amount of thinner into paint.	Estimate and measure volume.
Clean brushes and floor, using solvent or soap and water.	
May transfer items to and from work area, using hoist or hand-truck.	
May spray surfaces of machines, manufactured products or working area with paint, enamel, glaze, gelcoat or lacquer, using spray gun.	
May clean grease and dirt from product using lacquer thinner, turpentine, soap, and water.	
Apply masking tape over parts and areas that are not to be coated.	
Fill cavities and dents with putty to attain smooth surface.	
Select and mix coating liquid to produce desired color, according to specifications, using paddle or mechanical mixer.	Estimate volume.
Pour coating liquid into spray container.	Estimate volume and capacity.
Connect gun to airhose, using wrenches.	

PAINTERS (continued)

Occupational Task	Related Math
Turn sprayer valves and nozzle to regulate width and pressure of spray.	
Pull trigger and direct spray onto work surface.	
Coat areas inaccessible to hand sprayer using brush.	
Clean spraying equipment with solvent.	
May use acid, wire brush, or steel wool to remove rust from metal.	
May coat, decorate, glaze, retouch, or tint articles using airbrush.	
May plan work.	Estimate areas, volumes, materials needed, and costs. Read and write measurements. Add, subtract, multiply, and divide with whole numbers, fractions, and decimals. Solve problems involving ratios, proportions, and percents.

PLUMBERS

Occupational Task	Related Math
Study building plans and work drawings to determine work aids required and sequence of installation to assemble, install, and repair pipes, fittings, and fixtures of heating, water, and drainage systems, according to specifications and plumbing codes.	Read and measure from scale drawings. Estimate time, distance, quantity, area, and liquid volume.
Inspect structure to ascertain obstructions to be avoided to prevent weakening of structure resulting from installation of pipe.	Compute perimeter, area, volume, and equivalents. Determine sequence of operations.
Cut openings in walls and floors to accommodate pipe and pipe fittings, using handtools and power tools.	Measure lengths and diameters of pipes and fittings.
Locate and mark position of pipe and pipe connections and passage holes for pipes in walls and floors, using ruler, spirit level, and plumb bob.	Use ruler. Estimate and measure time, distance, weight, and capacity.
Cut and thread pipe, using pipe cutters, cutting torch, and pipe-threading machine.	Use a ruler.
Bend pipe to required angle by use of pipe-bending machine or by placing pipe over block and bending it by hand.	
Assemble and install valves, pipe fittings, and pipes composed of metals, such as iron, steel, brass, and lead, and nonmetals, such as glass, vitrified clay, and plastic, using handtools and power tools.	
Join pipes by use of screws, bolts, fittings, solder, plastic solvent, and calk joints.	

PLUMBERS (continued)

Occupational Task	Related Math
Fill pipe system with water or air and read pressure gages to determine whether system is leaking.	Read graduated scales.
Install and repair plumbing fixtures, such as sinks, commodes, bathtubs, water heaters, hot water tanks, garbage disposal units, dishwashers, and water softeners.	
Repair and maintain plumbing by replacing washers in leaky faucets, mending burst pipes, and opening clogged drains.	

RADIO AND TV SERVICEPERSONS

Occupational Task	Related Math
Use voltmeters, oscilloscopes, signal generators, and other electronic instruments to test voltages and resistances of circuits to isolate defects.	Read graduated scales. Follow schematic diagram. Read and measure from scale drawing. Read verniers. Compare fractions and decimals.
Tune receivers and observe audio and video characteristics to locate sources of trouble.	
Adjust controls to obtain desired density, linearity, focus, and size of picture.	
Examine chassis for defects.	
Test and change tubes.	
Solder loose connection and repair or replace defective parts, using hand tools and soldering iron.	
May prepare estimate of and bill for materials and services.	Read, write, say, and perform calculations with whole numbers and decimals.

(SHIPPING AND) RECEIVING CLERKS

Occupational Task	Related Math
Prepare items for shipment.	
Compare identifying information (count, weigh, or measure items) to verify against bills of lading, invoices, orders, or other records.	Say, read, write, and perform calculations with whole numbers, fractions, and decimals. Measure weight and time. Estimate distance. Read charts.
May determine method of shipment, utilizing knowledge of shipping procedures, routes, and rates.	Compare prices.
Assemble or select containers.	Estimate size and capacity.
Insert items into containers, using spacers, fillers, and protective padding.	
Nail covers on wooden crates and bind containers with metal tape, using strapping machine.	
Stamp, stencil, or glue identifying information and shipping instructions onto crates or containers.	Read, write, and say whole numbers, fractions, and decimals.
Post weights, shipping charges, and affix postage.	Write whole numbers, fractions, and decimals.
Unpack and examine incoming shipments.	
Reject damaged items and record shortages in order.	Write whole numbers and decimals.
Correspond with shipper to rectify damages and shortages.	Read and write whole numbers, fractions, and decimals.
Route items to departments.	
May operate tier-lift truck or use handtruck to move, convey, or hoist shipments from shipping-and-receiving platform to storage or work area.	Estimate weight.
May direct others in preparing outgoing and receiving incoming shipments.	Say whole numbers, fractions, and decimals.

SALES CLERKS

Occupational Task	Related Math
Write sales slips for items purchased.	Read, write, say, and perform calculations with whole numbers, fractions, and decimals. Total bills. Read tax charts. Define percentage.
Receive payment or prepare charge slip.	Calculate sales discounts. Recognize currency. Compare two amounts. Write whole numbers and decimals. Use calculator or cash register.
Make change.	Identify coins and paper bills. Count change.
Wrap or package customers' purchases.	
Stock shelves with merchandise.	Compare prices and merchandise identification numbers.
Maintain records of sales and inventory.	Read, write, and perform calculations with whole numbers, fractions and decimals. Compute net sales, given returns and allowances.
May assist customers by providing information about merchandise.	May need to estimate weight, distance, capacity, perimeter, and area.
Order replacement merchandise.	Read, write, and perform calculations with whole numbers, decimals, and fractions.
Perform computations to service customer or comply with requirements of supervisor.	Compute reduced selling prices given markdown percents. Compute selling price given cost and markup based on cost. Compute selling price given cost and markup based on selling price. Express profit as a percent of sales. Compute percentage, base, or rate given any two of the three. Convert fractions to decimals, decimals to percent, fractions to percent and vice versa.

SECRETARIES/CLERK TYPISTS

Occupational Task	Related Math
Schedule appointments.	Read, write, and say whole numbers. Estimate and measure time. Estimate distance.
Greet visitors/give information.	Give directions using numbers. Estimate and measure time. Estimate distance.
Take dictation.	Write whole numbers, fractions, percents, etc.
Read and route incoming mail.	Read, write, and count using whole numbers.
File correspondence.	Arrange a set of numbers in ascending or descending order.
Compose correspondence.	
Type correspondence, reports, etc.	Proofread numbers; set margins; and center.
Answer telephone.	Record numbers. Give directions using numbers.
Arrange travel schedule and reservations.	Estimate and measure time; use decimals; and record numbers.
Use copy machine.	Set counter; read, write, and say whole numbers.
Prepare outgoing mail.	Weigh outgoing mail to determine postage needed.
Order supplies.	Read, write, say, add, subtract, multiply, and divide with whole numbers, fractions, and decimals.

SHEET-METAL WORKERS

Occupational Task	Related Math
Follow job orders and blueprints to determine what tasks to perform and which procedures to use.	Calculate perimeter, area, and volume. Read and measure from scale drawings. Read, write, say, and perform calculations with whole numbers, fractions, and percents. Solve ratio and proportion problems.
Select gage and type of sheet metal according to product being fabricated and knowledge of metal.	Estimate and measure time, weight, distance, and capacity.
Locate and mark dimension and reference lines on metal sheet.	Measure distance.
Set up and operate fabricating machines, such as shears, brakes, banding rolls, and punch and drill presses to cut, bend, and straighten sheet metal.	Read graduated scales.
Shape metal over anvils, blocks, or forms, using hammer.	
Set up and operate soldering and welding equipment to join together sheet metal parts.	
Smooth seams, joints, or burred surfaces, using files and portable grinder or buffer.	
Install assemblies in plant or worksite according to blueprint specifications, using hand-tools and portable power tools.	Read and measure from scale drawings.
Inspect assemblies and installation for conformance with specifications, using measuring instruments, such as calipers, scales, and micrometer.	Read and measure from scale drawings.

TAXI DRIVERS

Occupational Task	Related Math
Pick up passengers in response to requests for services from dispatchers or when hailed.	
Handle luggage for passengers.	
Assist passengers boarding and leaving vehicle.	
Drive passenger to specified destination.	Read graduated scales. May read map and estimate distance and time.
Collect fees recorded on taxi-meters based on mileage and time.	Compare two numbers. Calculate difference. Count change.
Record transaction on log.	Measure time and distance (mileage). Write whole numbers and decimals.

TRACTOR-TRAILER DRIVERS

Occupational Task	Related Math
Operate gasoline or diesel-powered tractor-trailer over long distances.	Read graduated scales. Estimate time and distance. Maintain logs according to I.C.C. Regulations.
Maneuver vehicle in difficult situations.	Estimate distance, and time.
Inspect truck for defects before and after trips.	
Write report on truck conditions.	Read, write and perform calculations with whole numbers, fractions, and decimals. Measure time, weight, distance, and capacity, calculate perimeter, area, and volume.
Connect and disconnect airlines and hoses.	
Operate jack supports.	
May assist workers in loading and unloading truck.	

WAITERS/WAITRESSES

Occupational Task	Related Math
Set places.	Count place settings.
Write food orders.	Listen to, recognize, and record quantity (whole numbers and fractions).
Answer questions about items on the menu.	Say whole numbers and fractions. Estimate size and quantity. Estimate time.
Serve meals. May prepare beverages, salad, soup, etc.	Estimate capacity.
Observe customers to fulfill additional requests and to determine when meal has been completed.	
Prepare itemized checks.	Read, write, add, and subtract whole numbers and decimals. Calculate percentage.
Accept payment.	Compare two amounts. Make change.

APPENDIX D

Content Specifications
for Thirty Occupations

Title: Accounting Clerks/Bookkeepers: Prepare Invoices

Alternative Title: Accounting Clerks/Bookkeepers: Prepare Payrolls

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of accounting clerks such as

  --compiling and verifying data, posting ledger entries, and computing figures for financial statements and accounts

  --performing calculations with dollars and cents and calculating percents

  --typing vouchers, invoices, account statements, payrolls, and reports

  --computing credit, partial payments, and interest

- perform selected occupational and mathematics tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be an accounting clerk
- analyze characteristics of the work performed by accounting clerks in relation to his or her own interests and abilities

Possible Simulations:

Preparing invoices for department store customers including such tasks as calculating amounts due, percentages, and balance, and answering customers' questions about their accounts.

Preparing the payroll for a small construction company employing two carpenters, four laborers, a painter, an electrician, and an accounting clerk. Tasks will include determining weekly wages based on hourly pay and hours worked, solving percentage problems, and calculating payroll deductions.

Title: Barbers/Cosmetologists: Mix Hair Color

Alternative Title: Barbers/Cosmetologists: Record Service Charges

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of barbers and cosmetologists such as

  --styling and cutting hair

  --applying lotions, dyes, etc. to hair

  --recording service charges

  --accepting payment and giving change

- perform selected occupational and math tasks

- communicate with one or more other persons in the course of performing specified job tasks

- consider how one might prepare to be a barber and cosmetologist

- analyze chacteristics of the work performed by barbers and cosmetologists in relation to his or her own interests and abilities

Possible Simulation:

Measuring time and liquids (hair coloring or other solutions) when a knowledge of ratio is required.

Recording daily service charges.

Title: Carpenters: Calculate Board Feet

Alternative Titles: Carpenters: Read Scale Drawings

Carpenters: Measure and Construct

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of carpenters such as

  --selecting materials to be used

  --laying out and marking measurements on materials from blueprints, drawings, or samples

  --cutting and shaping materials

  --fastening materials together

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a carpenter
- analyze characteristics of the work performed by carpenters in relation to his or her own interests and abilities

Possible Simulations:

Calculating board feet and figuring the cost of lumber needed for a sun deck including such tasks as multiplying and dividing with whole numbers, decimals, and dollars and cents.

Reading scale drawings and scaling up, including determining the area of basic geometric figures in two rooms to be added onto a house.

Building such items as a bird house, tape box, or jewelry box; including such tasks as reading and measuring from scale drawings, scaling up, using measuring instruments, cutting and shaping materials, and fastening materials together.

Title: Cashiers: Receive Payments

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of cashiers such as

  --determining the total amount due, including tax

  --obtaining and checking customer identification cards when payment is made by check

  --giving customers change

  --preparing cashier drawer balance reports for the manager

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a cashier
- analyze characteristics of the work performed by cashiers in relation to his or her own interests and abilities

Possible Simulation:

Receiving payments from customers in a restaurant in cash and by check including such tasks as checking unit prices on a bill, totaling the amount due, determining tax, writing identifying information on the back of customers' checks, checking a credit list, and giving change.

Title: Combination Welders: Understand Basic Geometric Concepts

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of combination welders such as

  --reading work orders, blueprints, and layouts

  --operating machines and equipment to fuse bond, and cut metals

  --determining which of two measurements is more precise

  --understanding the basic geometric concepts of point, line, plane, parallel, perpendicular, and angles

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a combination welder
- analyze characteristics of the work performed by combination welders in relation to his or her own interests and abilities

Possible Simulation:

Understanding the basic geometric concepts of point, line, parallel, perpendicular, and angles in order to follow verbal or written instructions to perform a welding job.

Title: Computer Service Technicians:

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of computer service technicians such as

  --adjusting, oiling, and cleaning mechanical and electromechanical parts

  --determining cause(s) of failure of operation

  --measuring distances, voltages, time, and amperes

  --repairing failing parts or components

- perform selected occupational and mathematics tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a computer service technician
- analyze characteristics of the work performed by computer service technicians in relation to his or her own interests and abilities

Possible Simulation:

With an ohmmeter, measure and record electrical circuits of computer; record readings. If ohmmeter is not available, with voltmeter, measure/record volts of circuits and record readings. Calculate resistances of circuits using formula to determine ohms (resistances). Determine which circuits or parts may need repair or replacement. Check technical and repair manual for this specific computer. Record parts replaced and/or time repairing parts on a service order. List unit prices marked on new parts or check prices in catalog. Check all circuits and parts with ohmmeter after repair. Use voltmeter, if ohmmeter is not available, and calculate resistances to be certain circuit readings are appropriate/safe.

Note: Depending upon availability of a computer for the above, the simulation may only go as far as checking circuits and parts with ohmmeter or voltmeter, determining what is needed for repair or replacement, and writing up a service order with cost estimate for parts and work to be completed.

Title: Construction Laborers: Perform Linear Measurements

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of construction laborers such as

  --loading and unloading construction materials

  --mixing, pouring, and spreading materials

  --erecting and dismantling scaffolding, protective barriers, and lights

  --estimating and measuring length

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a construction laborer
- analyze characteristics of the work performed by construction laborers in relation to his or her own interests and abilities

Possible Simulation:

Performing linear measurements and comparing two measures.

Title: Cooks: Plan Dinner

Alternative Title: Cooks: Prepare a Meal

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of cooks such as

  --cleaning and preparing ingredients

  --measuring ingredients

  --regulating temperature gauges

  --requisitioning supplies

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a cook
- analyze characteristics of the work performed by cooks in relation to his or her own interests and abilities

Possible Simulations:

Planning a dinner for a party of 30 including such tasks as increasing basic recipes, multiplying whole numbers and fractions, preparing a shopping list, and estimating prices.

Preparing a meal for four including performing such tasks as measuring, mixing and baking foods; regulating an oven; and measuring time. (A simulation for home).

Title: Electricians: Use Wattmeter

Alternative Titles: Electricians: Plan Electrical Layout
Electricians: Prepare a Bid to Wire a Room

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of electricians such as

  --planning the layout of wiring, electrical fixtures, and control equipment

  --measuring from scale drawings

  --repairing faulty equipment or systems

  --connecting wiring to lighting fixtures and power equipment, using hand tools

- perform selected occupational and mathematics tasks

- communicate with one or more other persons in the course of performing specified job tasks

- consider how one might prepare to be an electrician

- analyze characteristics of the work performed by electricians in relation to his or her own interests and abilities

Possible Simulations:

Using a wattmeter to measure current flow and voltage in one reading. Check appliances against manufacturer's ratings--appliance ratings should operate within a tolerance of $\pm$ 10%.

Plan the electrical layout for a kitchen to have 4-110 volt outlets, 1-220 volt outlet, an overhead light with a wall switch, and a sink light with a wall switch. Separate fuses should be used for (1) the 220 volt outlet, (2) the 110 volt outlets, and (3) the lights.

Based on a description of a room to be wired and the specifications and prices of materials, prepare a bid for the job showing the costs and a reasonable profit for the labor.

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Title: Farmers: Read Charts

Alternative Title: Farmers: Keep Records

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of farmers such as

  --selecting and buying the type and amount of seed to be grown

  --planting, cultivating, and harvesting a crop

  --operating a variety of equipment and machinery

  --planning and coordinating farm activities

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a farmer
- analyze characteristics of the work performed by farmers in relation to his or her own interests and abilities

Possible Simulation:

Reading charts to determine how much seed, fertilizer, and other products are needed for two different fields of specified dimensions.

Keeping records of costs and profit/loss for planting and havresting wheat in a 10 acre field.

Keeping records of costs and profit/loss regarding raising livestock(chickens, turkeys, hogs, beef cattle, etc.).

Title: Heavy Equipment Operators: Determine Volume and Estimate Truck loads

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of heavy equipment operators such as

  --adjusting valves to control air and water outputs of machines

  --adjusting handwheels and depressing pedals to drive machines

  --controlling attachments such as blades, buckets, and scrapers

  --estimating weight, time, volume, area, and distance

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a heavy equipment operator
- analyze characteristics of the work performed by heavy equipment operators in relation to his or her own interests and abilities

Possible Simulation:

Determining the number of truckloads of earth to be excavated for the basement of a house by an earthmover. Using blueprint dimensions of a basement determine volume and estimated weight of earth to be removed and approximate number of truckloads of earth to be moved.

Title: Janitors and Maintenance Persons: Determine Repair and Improvement Needs

Alternative Title: Janitors and Maintenance Persons: Gather Cost Information

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of janitors and maintenance persons such as

  --cleaning floors, steps, washrooms, and windows

  --mowing grass, trimming shrubbery, and clearing away snow and debris from specified areas

  --performing minor painting and carpentry tasks

  --estimating and measuring volume, area, weight, and time

- perform selected occupational and math skills
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a janitor and maintenance person
- analyze characteristics of the work performed by janitors and maintenance persons in relation to his or her own interests and abilities

Possible Simulations:

Determining repair and improvement needs in an apartment complex including such tasks as recording the nature of the problem and the apartment number and estimating quantities, sizes, etc. of materials needed to perform required repairs.

Gather cost information for open bids.

Title: Local Truck Drivers: Plan Deliveries

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of local truck drivers such as

  --reading/recording odometer readings

  --reading street maps, street signs, and building numbers

  --estimating distance and time

  --verifying items delivered against shipping orders

- perform selected occupational and mathematics tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a local truck driver
- analyze characteristics of the work performed by local truck drivers in relation to his or her own interests and abilities

Possible Simulations:

Plan and carry out deliveries for a department store including such tasks as estimating the distance of each delivery site from the warehouse using a map, grouping orders by area, preparing a delivery route with estimated arrival times, reading and comparing house numbers with the prepared route list, verifying items delivered against shipping orders, and obtaining signatures from persons who receive the orders.

Title: Machinists: Perform Semiprecision Layout

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of machinists such as

  --studying blueprints, sketches, damaged parts or descriptions of parts

  --measuring, marking, and scribing dimensions and reference points

  --using handtools to fit and assemble parts to assemblies or mechanisms

  --setting up and operating machines

- perform selected occupational and mathematics tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a machinist
- analyze characteristics of the work performed by machinists in relation to his or her own interests and abilities

Possible Simulation:

Using a 6" rule and a scriber lay out a part on a piece of metal as specified on a blueprint.

Title: Maintenance Mechanics: Use Rules, Calipers, and Micrometers

Alternate Title: Maintenance Mechanics: Determine Speed for Conveyors

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of maintenance mechanics such as

  --observing and listening to mechanical devices in operation to locate causes of trouble

  --reading diagrams, sketches, and operation manuals

  --repairing engines, motors, pneumatic tools, conveyor systems and production machines

  --solving ratio and proportion problems

- perform selected occupational and mathematics tasks

- communicate with one or more other persons in the course of performing specified job tasks

- consider how one might prepare to be a maintenance mechanic

- analyze characteristics of the work performed by maintenance mechanics in relation to his or her own interests and abilities

Possible Simulation:

Using rules, calipers, and micrometers, measure the parts of a desk from a front and top view. Draw a two-view blueprint of the unit.

Using specifications such as package dimensions and production volume, calculate speed for conveyors and transfer mechanisms.

Title: Meat Cutters: Read Scales

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of meat cutters such as

  --cutting and trimming meat

  --using tools such as grinders, cubing machines, and power saws

  --shaping, lacing, and tying meat cuts

  --weighing, pricing, and wrapping meat

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a meat cutter
- analyze characteristics of the work performed by meat cutters in relation to his or her own interests and abilities

Possible Simulation:

Reading scales to determine weight and cost of a cut of meat, fish, or poultry.

Title: Metal Product Assemblers: Construct from specifications

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of metal product assemblers such as

  --reading drawings and specifications

  --measuring, filing, and scraping parts to produce close fits

  --operating machines to assist in assembly operation

  --aligning holes and using hand and portable power tools to fasten parts together

- perform selected occupational and mathematics tasks

- communicate with one or more other persons in the course of performing specified job tasks

- consider how one might prepare to be a metal product assembler

- analyze characteristics of the work performed by metal product assemblers in relation to his or her own interests and abilities

Possible Simulation:

Reading a diagram to construct a lazy Susan (a revolving tray for serving food) including interpreting specifications, performing measurements, and fitting pieces together.

Title: Motor Vehicle Mechanics and Construction-Equipment Mechanics: Read Graphs

Alternative Title: Motor Vehicle Mechanics and Construction-Equipment Mechanics: Use a Micrometer

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of motor vehicle mechanics such as

  --examining vehicles to identify the value and extent of repairs needed

  --planning work procedures using manufacturers' charts, technical manuals, and experience

  --repairing and replacing malfunctioning parts

  --preparing bill for parts and service

- Perform selected occupational and mathematics tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a motor vehicle mechanic
- analyze characteristics of the work performed by motor vehicle mechanics in relation to his or her own interests and abilities

Possible Simulation:

Determine the number of gallons of antifreeze to purchase to protect a vehicle down to +5 degrees.

Using a micrometer to determine whether the valves in a vehicle are in proper working order or the degree to which they need to be ground.

Title: Nursing Aides/Assistants: Find Vital Signs

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of nursing aides/assistants such as

  --answering signal lights to determine patients' needs

  --taking and recording patients' temperature, pulse, and respiration rates

  --bathing, dressing, and undressing patients

  --changing bed linens

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a nursing aide/assistant
- analyze characteristics of the work performed by nursing aides/assistants in relation to his or her own interests and abilities

Possible Simulation:

Taking and recording nursing home patients' vital signs including such tasks as reading graduated scales; telling time; and saying, reading, writing, and comparing whole numbers.

Title: Painters: Determine Area

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of painters such as

  --planning work, including estimating area to be painted, volume of paint required, and cost of paint and other materials

  --cleaning surfaces to be painted

  --selecting and mixing coating liquid to produce desired color

  --applying paint using spray gun, brush, and/or roller

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a painter
- analyze characteristics of the work performed by painters in relation to his or her own interests and abilities

Possible Simulation:

Identifying geometric shapes and determining their area in order to estimate the area to be painted and the amount of paint needed.

Title: Plumber: Locate Pipes

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of plumbers such as

  --repairing and maintaining plumbing by replacing washers in leaky faucets, mending burst pipes, and opening clogged drains

  --installing and repairing plumbing fixtures such as sinks, commodes, and bathtubs

  --measuring lengths and diameters of pipes and fittings

  --cutting openings in walls and floors to accommodate pipe and pipe fittings

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a plumber
- analyze characteristics of the work performed by plumbers in relation to his or her own interests and abilities

Possible Simulation:

Locating and marking position of pipe, pipe connections, and passage holes for pipes in walls and floors using a ruler including such tasks as reading and measuring from a scale drawing and performing measurements.

Title: Programmers:

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of programmers such as

  --organizing data

  --determining unknowns of problems and defining and coding given information

  --writing/applying basic computer language (coding) in logical steps for problem solving

  --testing the operation of the program

- perform selected occupational and mathematics tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a programmer
- analyze characteristics of the work performed by programmers in relation to his or her own interests and abilities

Possible Simulation:

Demonstrate/develop flow chart for writing a program. Flow chart demonstrated will show the basic steps by words and flow chart format for solving a simple problem of general interest to students; (for example, determine the average grade of students on a math test; determine amount of over-spending or under-spending of a student budget for one month).

Organize data and apply basic computer language (e.g., binary/number system) to the problem by stating in computer language the procedures for making the calculations.

Title: Radio and Television Service Persons: Read a volt-ohm-milliammeter (multimeter)

Alternative Title: Radio and Television Service Persons: Estimate Operating Cost

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of radio and television service persons such as

  --using electronic instruments to test voltages and resistances of circuits to isolate defects

  - tuning receivers and observing audio and video characteristics to locate sources of trouble

  --repairing or replacing defective parts

  --preparing estimates and bills for materials and services

- perform selected occupational and mathematics tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a radio and television service person
- analyze characteristics of the work performed by radio and television service persons in relation to his or her own interests and abilities

Possible Simulation:

Using a volt-ohm-milliammeter measure the current flow and voltage used by two radios and one portable black and white television. Compare these measurements with the requirements (current and volts) of the three units.

Estimate the operating costs of a radio, a black and white television, and a color television for a four-hour period using the formula

$$\frac{\text{watts} \times \text{hours} \times \text{rate}}{1{,}000} = \text{Total Cost}$$

Title: Receiving Clerks: Check Deliveries

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of receiving clerks such as

  --unpacking and examining incoming shipments

  --comparing identifying information about articles with written records such as orders, invoices and bills of lading

  --corresponding with shipper to rectify damages and shortages

  --counting, weighing, and measuring items

- perform selected occupational and mathematics tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a receiving clerk
- analyze characteristics of the work performed by receiving clerks in relation to his or her own interests and abilities

Possible Simulation:

Comparing original orders with invoices including such tasks as recording shortages in order, checking accuracy of total charges, and calling or corresponding with shippers to rectify shortages.

Title: Sales Clerks: Calculate Discounts

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of sales clerks such as

  --writing sales slips for items purchased

  --receiving payment or preparing charge slips

  --making change

  --packaging customers' purchases

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a sales clerk
- analyze characteristics of the work performed by sales clerks in relation to his or her own interests and abilities

Possible Simulation:

Calculating sales discounts and total bills for customers in a record shop, including such tasks as computing percentage, adding and subtracting dollars and cents, reading a tax chart, and giving change.

Title: Secretaries/Clerk Typists (Stenographers): Make Travel Arrangements

Alternative Title: Secretaries/Clerk Typists (stenographers): Proofread Sales Reports

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of secretaries such as

  --reading and routing incoming mail

  --typing correspondence and reports

  --answering the telephone and taking and giving information

  --arranging for travel schedules and reservations

- perform selected occupational and math tasks

- communicate with one or more other persons in the course of performing specified job tasks

- consider how one might prepare to be a secretary

- analyze characteristics of the work performed by secretaries in relation to his or her own interests and abilities

Possible Simulations:

Making travel arrangements for salespersons including such tasks as calling travel agents, estimating and calculating travel costs, totaling estimates, and completing a travel form.

Proofreading typed sales reports using a handwritten copy including such tasks as comparing numbers, checking calculations, and correcting spelling and punctuation errors.

Title: Sheet-Metal Workers: Read Scale Drawings

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of sheet-metal workers such as

  --following job orders and blue prints

  --calculating perimeter, area, and volume

  --locating and marking dimension and reference lines on metal sheet

  --shaping metal over anvils, blocks, or forms, using a hammer

- perform selected occupational and mathematics tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a sheet-metal worker
- analyze characteristics of the work performed by sheet-metal workers in relation to his or her own interests and abilities

Possible Simulation:

Determining the amount of sheet metal needed for specified parts of a furnace from information given on a scale drawing.

Title: Taxi Drivers: Make Change

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of taxi drivers such as

  --picking up passengers and driving them to specified locations

  --reading street maps, street signs, and building numbers

  --collecting fares and giving change

  --recording daily transactions on a log

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a taxi driver
- analyze characteristics of the work performed by taxi drivers in relation to his or her own interests and abilities

Possible Simulations:

Reading a meter to determine amount due for a taxi ride, requesting amount due from a passenger, and counting a passenger's change orally. Fill out a receipt and give it to the customer.

Title: Tractor-Trailer Driver: Estimate Time, Distance, and Cost

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of tractor-trailer drivers such as
  - --operating and maneuvering a tractor-trailer
  - --inspecting the truck for defects before and after trips
  - --maintaining a log according to I.C.C. regulations
  - --reading a road map
- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a tractor-trailer driver
- analyze characteristics of the work performed by tractor-trailer drivers in relation to his or her own interests and abilities

Possible Simulation:

Estimating time, distance, and the cost of fuel required for a three-day trip with specified stops; including such tasks as reading a map and estimating distance in miles, time in hours, and the cost of fuel).

Title: Waiters/Waitresses: Serve Customers

Objectives: The Student Will

- become aware of the many occupational and mathematics skills required of waiters/waitresses such as

  --developing rapport with customers

  --writing accurate and easily read orders

  --carrying and balancing dishes or heavy trays, or maneuvering carts

  --recording prices of items on customers' checks

- perform selected occupational and math tasks
- communicate with one or more other persons in the course of performing specified job tasks
- consider how one might prepare to be a waiter/ waitress
- analyze characteristics of the work performed by waiters/waitresses in relation to his or her own interests and abilities

Possible Simulation:

Serving customers in a restaurant including such tasks as greeting customers, asking for food and beverage orders, recording orders, serving food, looking up and recording prices of orders using a menu, and totaling checks.

APPENDIX E

Pilot Test Teacher Evaluation Form

161

BOOKLET TITLE _____ LAM

PILOT TEST REVIEW INSTRUMENT

Section Considered	Usability Rating (Check One for Each Section)	Major Strength(s)	Weakness(es) and Suggested Resolutions
Booklet Introductory Information (Have You Ever; What Will You Learn; Some Important Things; How Can or What Are; How Use Math; What Is It like to Be)	☐ Very High ☐ High ☐ Average ☐ Marginal ☐ Very Low		Weakness(es): Suggested Resolutions:
Booklet Simulation Section (You Will Work with Others; Working with Others; Change Roles; Self Assessment)	☐ Very High ☐ High ☐ Average ☐ Marginal ☐ Very Low		Weakness(es): Suggested Resolutions:
Booklet Summary/Closure (How Get a Job; What Are Similar Jobs; Where to Go from Here; Things to Think, Talk about, and Do; Glossary)	☐ Very High ☐ High ☐ Average ☐ Marginal ☐ Very Low		Weakness(es); Suggested Resolutions:
Related Materials (Facilitator; Consumable Materials; Support Materials; More Problems)	☐ Very High ☐ High ☐ Average ☐ Marginal ☐ Very Low		Weakness(es)· Suggested Resolutions:

Is the simulation useful in providing a framework for students to perform occupational tasks and job-related mathematics?

Would you use this simulation with your students?

Why or why not?

Other Comments:

APPENDIX F

Pilot Test Subject Matter
Expert Evaluation Form

BOOKLET TITLE _____

PILOT TEST REVIEW INSTRUMENT

SECTION CONSIDERED	USABILITY RATING (CHECK ONE FOR EACH SECTION)	MAJOR STREHGTH(S)	WEAKNESS(ES) AND SUGGESTED RESOLUTIONS
Booklet Introductory Information (Have You Ever; What Will You Learn; Some Important Things; How Can or What Are; How Use Math; What Is It Like to Be)	☐Very High ☐High ☐Average ☐Marginal ☐Very Low		Weakness(es) Suggested Resolutions:
Booklet Simulation-Related Sections (You Will Work with Others; Working with Others; Change Roles; Self Assessment)	☐Very High ☐High ☐Average ☐Marginal ☐Very Low		Weakness(es) Suggested Resolutions:
Booklet Summary/Closure (How Get a Job; What Are Similar Jobs; Where to Go From Here; Things to Think, Talk about, and Do; Glossary)	☐Very High ☐High ☐Average ☐Marginal ☐Very Low		Weakness(es) Suggested Resolutions.
Simulated Materials (Facilitator; Consumable Materials; Support Materials)	☐Very High ☐High ☐Average ☐Marginal ☐Very Low		Weakness(es) Suggested Resolutions.
More Proglems Materials	☐Very High ☐High ☐Average ☐Marginal ☐Very Low		Weakness(es) Suggested Resolutions

Is the simulation useful in providing a framework for students to perform occupational tasks and job-related mathematics?

Would you use this simulation with your students?

Why or why not?

Other Comments:

BOOKLET TITLE_____

FORMATIVE EVALUATION INSTRUMENT (FORMAT)

TOPIC	MAJOR STRENGTH(S)	WEAKNESS(ES) AND SUGGESTED RESOLUTIONS
Packaging		Weakness(es): Suggested Resolutions:
Illustrations		Weakness(es): Suggested Resolutions:
Print		Weakness(es): Suggested Resolutions:
Language		Weakness(es): Suggested Resolutions:
Exercises		Weakness(es): Suggested Resolutions:
Simulation (Role Play)		Weakness(es): Suggested Resolutions:

APPENDIX G

Intake Assessment Instrument

PRETEST

FIELD TEST BOOKLETS/RELATED MATERIALS
(cooks, nursing aides/assistants, secretary-clerk typists, plumbers, sheet metal workers, machinists, sales clerks, and combination welders)

ITEM 1: _____
Date Test Given

ITEM 2: ○ Experimental Group

○ Control Group

Directions: Write the letter of the correct answer in the blank in front of the item number.

Illustration:

d A. Vital signs are (a) lights or buzzers used by patients to call a nursing aide or assistant (b) signals via patients' input and output patterns that they are getting well (c) directions given by a doctor to a nursing aide or assistant (d) evidence of life such as temperature, pulse, and breathing rate.

_____ 1. Photographic prints in white on a blue ground used for copying maps, architectural drawings, and plans are called

(a) scale drawings

(b) photo-copies

(c) blueprints

(d) prints

_____ 2. A tool that plumbers use to clean burrs and rough surfaces from the inside edges of pipes or tubes after cutting is called a

(a) reamer

(b) chisel

(c) pipe threader

(d) tube cutter

_____ 3. Training programs that are conducted by unions, such as a plumbers' union, are called _____ training programs.

(a) on the job

(b) classroom

(c) apprenticeship

(d) entry level

_____ 4. Plumbers use torches to heat metal pipes so they can be connected. A metallic alloy is melted onto the pipe surface and joins the pipe together. This method is called

(a) torching

(b) welding

(c) melting

(d) soldering

_____ 5. The parts or connectors that plumbers use to join lengths of pipe together are called

(a) joints

(b) fittings

(c) contacts

(d) fixtures

_____ 6. One way to learn the skills needed to work as a sheet metal worker is to enter an _____ program.

Item deleted from analysis.

(a) high school vocational

(b) on-the-job training

(c) apprenticeship program

(d) all of the above

_____ 7. A measuring instrument used by sheet metal workers to make small, precise measurements is called a

(a) protractor

(b) tape measure

(c) micrometer

(d) folding rule

_____ 8. A _____ drawing of an object is one in which smaller units of measure are used to represent the object's true units of measure. (For example, 1" = 1')

(a) metric

(b) scale

(c) linear

(d) ratio

_____ 9. Detailed plans, written descriptions, or precise presentations are called

(a) blueprints

(b) scale drawings

(c) outlines

(d) specifications

_____10. An example of work a sheet metal worker performs is

(a) install & repair heating systems

(b) repair damaged automobile bodies

(c) install machinery

(d) repair damaged appliances

_____11. The rate at which stock is fed into a machine is called

(a) rate of input

(b) stock rate

(c) machine rate

(d) rate of feed

(e) none of the above

_____12. An instrument used to measure and construct angles is called a

(a) T-square

(b) caliper

(c) protractor

(d) compass

_____13. A _____ machine is used for removing the surface of a piece of metal or for cutting grooves in it.

(a) sanding

(b) drilling

(c) sawing

(d) milling

_____14. The maximum permitted errors in a work piece are called

(a) tolerances

(b) limits

(c) boundaries

(d) extensions

_____15. A _____ _____ is an instrument with a threaded barrel used for making precise external measurements.

(a) folding rule

(b) carpenter's square

(c) vernier caliper

(d) tape measure

_____16. Valves that control the flow of gases to the weld are called

(a) resistors

(b) registers

(c) regulators

(d) none of the above

_____17. Welders use math to

(a) read blueprints

(b) identify metals

(c) select filler rods

(d) none of the above

_____18. An example of safety equipment a welder should use is a

(a) safety harness

(b) face mask

(c) smoke detector

(d) all of the above

_____19. The _____ system is a decimal system of weights and measures which uses the base 10 in all the scales.

(a) British standard

(b) linear

(c) United States dry

(d) metric

_____20. A welding process that makes use of heat generated by an electric current flowing between a metal electrode and a work piece is called

(a) oxyacetylane welding

(b) soldering

(c) arc welding

(d) combination welding

_____21. A _____ is the amount of money subtracted from the usual price of an item.

(a) debit

(b) discount

(c) deduction

(d) difference

_____22. An example of how sales clerks use math is

Item deleted from analysis.

(a) making change

(b) stocking shelves

(c) showing merchandise

(d) figuring postage

_____23. A piece of equipment used frequently by sales clerks is a

(a) personal computer

(b) typewriter

(c) stapler

(d) cash register

_____24. A list of the types and quantity of goods or materials on hand in a business is called an

(a) invoice

(b) instrument

(c) inventory

(d) invention

_____25. A written or printed statement showing that a service or product is paid for is called a

(a) recipe

(b) resume

(c) receipt

(d) record

_____26. The directions a cook follows when preparing a special food are called

(a) receipts

(b) references

(c) recipes

_____27. The foods and seasonings cooks combine to prepare a special food are called

(a) elements

(b) ingredients

(c) assemblies

_____28. Cooks use math most often to

(a) measure amounts of food

(b) total tips they receive

(c) keep track of time worked

_____29. A tool a cook would most likely use is a

(a) drill

(b) blender

(c) grouter

_____30. You can prepare to be a cook by taking courses in

(a) shop math

(b) food services

(c) sales

_____31. Communication by letter or report is called

(a) corrosion

(b) computation

(c) correspondence

(d) condensation

_____32. When a secretary or clerk typist checks and reviews typed pages and corrects errors on the pages, he or she _____ them.

(a) proofreads

(b) edits

(c) examines

(d) tests

_____33. An example of how secretaries use math in their work is

Item deleted from analysis.

(a) record on a dictaphone

(b) set margins on a typewriter

(c) operate a word processor

(d) type correspondence

_____34. A _____ machine is a special tape recorder used to record oral directions.

(a) designing

(b) dissecting

(c) defining

(d) dictating

_____35. A secretary who specializes in working for a lawyer is called a

(a) lawful secretary

(b) law clerk

(c) legal secretary

(d) secretary of law

_____36. Nursing aides and assistants are usually

(a) registered nurses

(b) college graduates

(c) are trained on the job

(d) graduates from a 2-year technical school

_____37. A typical task for a nursing aid or assistant is to

(a) give medicine to patients

(b) give baths to patients

(c) give shots to patients

_____38. If, as a nursing aide, you were told to clean equipment, you would _____ it.

(a) sterilize

(b) cauterize

(c) sanitize

_____28. Cooks use math most often to

(a) measure amounts of food

(b) total tips they receive

(c) keep track of time worked

_____29. A tool a cook would most likely use is a

(a) drill

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(a) give medicine to patients

(b) give baths to patients

(c) give shots to patients

_____38. If, as a nursing aide, you were told to clean equipment, you would _____ it.

(a) sterilize

(b) cauterize

(c) sanitize

_____39. An important task that nursing aides perform in their work is

(a) take and record patients' vital signs

(b) assist doctors with surgery

(c) admit patients to the hospital

(d) give directions to nurses

_____40. An example of how nursing aides use math in their work is

Items deleted from analysis.

(a) follow directions

(b) read thermometers

(c) record information

APPENDIX H

Posttest Instrument

DATE: _____

CITY: _____

GROUP: X C

TYPE: E L M

SEX: M F

SECTION 1

Directions: On the blank in front of each item, write the letter of the answer that agrees most with the way you think or feel. THERE ARE NO RIGHT OR WRONG ANSWERS.

_____ 1. I see no real value in learning what courses I need to complete in order to enter different occupations.

(a) Yes

(b) Uncertain

(c) No

_____ 2. Skills in basic mathematics are not very important to someone who wants to become a sales clerk.

(a) Yes

(b) Uncertain

(c) No

_____ 3. All students my age should know the education and training requirements for different jobs.

(a) Yes

(b) Uncertain

(c) No

_____ 4. Most workers use basic math skills on their job almost every day.

(a) Yes

(b) Uncertain

(c) No

_____ 5. Learning about the education and training requirements of different jobs is a waste of time.

(a) Yes

(b) Uncertain

(c) No

_____ 6. Most workers need to be skilled in solving basic mathematics problems.

(a) Yes

(b) Uncertain

(c) No

_____ 7. I really enjoy learning about the education and training requirements of different occupations.

(a) Yes

(b) Uncertain

(c) No

_____ 8. To do their job well secretaries need to be able to solve basic mathematics problems.

(a) Yes

(b) Uncertain

(c) No

_____ 9. Basic math skills are an important part of every occupation.

(a) Yes

(b) Uncertain

(c) No

_____ 10. Are there any apprenticeship programs you would like to know more about?

(a) Yes

(b) Uncertain

(c) No

SECTION 2

Directions: On the blank in front of each item, write the letter of the best answer.

_____ 1. Many states require cooks to wear hats because hats_____.

(a) look nice

(b) keep hair from falling in the food

(c) are worn by important people

(d) help people think better

_____ 2. Combination welders_____.

(a) paint materials

(b) join metal parts by heating them

(c) make cement

(d) operate a word processor or typewriter

_____ 3. Machinists use math to_____.

(a) make change

(b) determine depth of cut in a piece of metal

(c) figure commission rates and discounts

(d) take vital signs

____ 4. To become a good sales clerk you should_____.

(a) feel comfortable being around and talking to strangers

(b) not always tell the truth about merchandise

(c) learn to discourage customers from buying expensive items

(d) not listen to what customers say

___ 5. One way to learn how to be a plumber is to_____.

(a) enter an apprenticeship program

(b) practice taking vital signs

(c) figure mark-downs or discounts for customers

(d) measure liquid intake and output

_____ 6. As a nurse aide or assistant you_____.

(a) talk to patients' relatives about patients' conditions

(b) help make patients feel comfortable

(c) never touch or talk to patients

(d) help doctors perform surgery

_____ 7. Sheet-metal workers use math to_____.

(a) measure pipe fittings

(b) determine welding tip sizes

(c) convert scale measurements to actual size

(d) take and record vital signs

_____ 8. Secretaries and clerk typists use math to_____.

(a) clean a typewriter

(b) set margins on a typewriter

(c) change ribbons on a typewriter

(d) total the tips they receive

_____ 9. Combination welders use math to_____.

(a) set and read gas pressure gauges

(b) select filler rods

(c) identify metals

(d) make cement

_____ 10. One example of a vital sign is the_____.

(a) stock rate

(b) rate of feed

(c) commission rate

(d) pulse rate

_____ 11. A _____ uses power driven tools to cut, shape, and finish metal parts for machines.

(a) welder

(b) machinist

(c) sheet-metal worker

(d) plumber

_____ 12. Sales clerks frequently use a _____ in their job.

(a) frying pan

(b) microphone

(c) typewriter

(d) cash register

_____ 13. A plumber needs to know how to_____.

(a) operate office machines

(b) figure mark-downs

(c) measure food and liquid intake and output

(d) read blueprints and scale drawings

_____ 14. Secretaries and clerk typists work_____.

(a) outdoors

(b) in casual clothes

(c) alone and without interuptions

(d) in offices

_____ 15. Sheet-metal workers need to know _____.

(a) good safety rules

(b) how to forecast the weather

(c) how to make change

(d) about word processors

_____ 16. Cooks need to know how to _____.

(a) read and follow recipes

(b) type letters

(c) take vital signs

(d) read blueprints and calipers

_____ 17. An example of a tool used by a plumber is a _____.

(a) measuring cup

(b) stapler

(c) reamer

(d) cash register

_____ 18. Secretaries and clerk typists _____.

(a) take vital signs

(b) prepare letters and reports

(c) give change

(d) have to stand for long periods of time

_____ 19. A micrometer would be used by a _____.

(a) cook

(b) sales clerk

(c) sheet-metal worker

(d) nurse aide or assistant

_____ 20. Nurse aides and assistants are usually _____.

(a) trained on the job

(b) registered nurses

(c) college graduates

(d) enrolled in apprenticeship programs

_____21. To be a welder, you should take classes in _____.

(a) cooking

(b) typing

(c) blueprint reading and drafting

(d) repairing damaged appliances

_____ 22. Cooks use math to_____.

(a) increase and decrease recipes

(b) practice good personal hygiene

(c) solder metals together

(d) count change

_____ 23. A person who is a _____is likely to have completed an apprenticeship program.

(a) secretary

(b) nurse aide

(c) sales clerk

(d) machinist

_____ 24. Sales clerks use math to_____.

(a) total the tips they receive

(b) take center-to-center measurements

(c) figure mark-downs

(d) record temperatures

_____ 25. A blender is most likely used by a _____.

(a) plumber

(b) welder

(c) nurse aide

(d) cook

_____ 26. A machinist must be able to_____.

(a) set up and operate machine tools

(b) make, install, and repair ducts

(c) tighten fittings after replacing a leaky fixture

(d) use a dictating machine

_____ 27. Some sales clerks are paid a _____.

(a) quota

(b) reamer

(c) commission

(d) momento

_____28. An example of the kind of work a sheet-metal worker does is_____.

(a) install and repair heating systems

(b) repair damaged furniture

(c) install lighting

(d) repair damaged appliances

_____ 29. To be a secretary or clerk typist you should be_____.

(a) an apprentice

(b) a plumber's helper

(c) a high school graduate

(d) able to count change accurately

_____ 30. Plumbers use math to_____.

(a) count change

(b) take center-to-center measurements

(c) tighten fittings

(d) increase or decrease a recipe

_____ 31. Nurse aides use math in their work to_____.

(a) lift and move patients

(b) read thermometers

(c) help dress and undress patients

(d) diagnose illnesses

_____ 32. When oxyacetylene welding, a welder uses _____ to control the flow of gases.

(a) resistors

(b) registers

(c) regulators

(d) recipes

APPENDIX I

Student Evaluation Form

STUDENT EVALUATION FORM

Directions: Please answer these questions about the Using Math on the Job booklets. This is not a test. THERE ARE NO RIGHT OR WRONG ANSWERS.

_____ 1. I think the Using Math on the Job booklets are _____.

(a) interesting

(b) boring

(c) okay

_____ 2. I think the information in the Using Math on the Job booklets is _____.

(a) too childish

(b) hard to understand

(c) about right for me

_____ 3. I think the math problems in the Individual Simulation and More Math Problems Sections were _____.

(a) too easy

(b) sort of hard but I figured them out

(c) too hard

_____ 4. Which booklet did you like the most?

(a) Cooks

(b) Secretaries/Clerk Typists

(c) Welders

(d) Nurse Aides/Assistants

(e) Plumbers

(f) Sales Clerks

(g) Machinists

(h) Sheet-Metal Workers

_____ 5. Which booklet did you like the least?

(a) Cooks

(b) Secretaries/Clerk Typists

(c) Welders

(d) Nurse Aides/Assistants

(e) Plumbers

(f) Sales Clerks

(g) Machinists

(h) Sheet-Metal Workers

APPENDIX J

Teacher Evaluation Form

USING MATH ON THE JOB

TEACHER EVALUATION

Directions. Please mark the response that best indicates your feeling regarding the materials developed for the series Using Math On The Job. On this form, the word materials refers to all written materials for all occupations. Set of material refers to the booklets and related materials for specific occupations.

1. Given the current level of development and form of these materials, do you feel they should be disseminated nationally to teachers?

_____ Yes, with no changes Comments _____

_____ Yes, with minor changes _____

_____ Yes, with major changes _____

_____ No

2. How was the maturity level of the materials for your students?

_____ Too Childish _____ Just Right _____ Too Mature

Comments _____

_____

3. What did you think of the illustrations?

_____ I like the "original" art more than the clip art.

_____ I like the clip art more than the "original" art.

_____ I like the clip art and "original" art equally.

Comments _____

_____

4. How was the vocabulary level of the material for your students?

_____ Too Easy _____ Just Right _____ Too Difficult

Comments _____

_____

5. Overall, what was the student interest level in these materials?

_____ High _____ Moderate _____ Indifferent

_____ Low _____ Strongly Disliked _____ Can't Rate

Comments _____

_____

6. From an instructional perspective, what rating would you assign to these materials?

_____ Excellent _____ Good _____ Fair _____ Poor

Comments _____

_____

7. How would you rate the format used to organize and present information in these materials?

_____ Excellent _____ Good _____ Fair _____ Poor

Comments _____

_____

8. Do you feel any major additions, changes, or deletions should be made to the materials?

_____ No

_____ Yes - List those additions, changes, or deletions below:

_____

_____

9. In terms of quality, how would you rank the 8 sets of materials? (Use 1 for the poorest set and 8 for the best.)

Set	Ranking
Cooks	_____
Secretaries/Clerk Typists	_____
Welders	_____
Nurse Aides/Assistants	_____
Plumbers	_____
Sales Clerks	_____
Machinists	_____
Sheet-Metal Worker	_____

10. For the set of materials you ranked as the best (i.e., as 8), how informative and useful is the information and material presented in the:

	Circle one rating for each section	If you rated a section as poor, how would you improve it?
• What Do (occupation) Do section	Excellent Good Poor	Comments _____
• What Is It Like To Be A (occupation) section	Excellent Good Poor	Comments _____
• What Do (occupation) Need to Know section	Excellent Good Poor	Comments _____
• How Do (occupation) Use Math section	Excellent Good Poor	Comments _____
• What Training, Education, and Experience Do You Need To Become A (occupation) section	Excellent Good Poor	Comments _____
• Individual Simulation section	Excellent Good Poor	Comments _____
• More Problems section	Excellent Good Poor	Comments _____
• Group Simulation section	Excellent Good Poor	Comments _____

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11. For the set of materials you ranked as the poorest (i.e., as 1), how informative and useful is the information and material presented in the:

	Circle one rating for each section	If you rated a section as poor, how would you improve it?
• What Do (occupation) Do section	Excellent Good Poor	Comments _____
• What Is It Like To Be A (occupation) section	Excellent Good Poor	Comments _____
• What Do (occupation) Need to Know section	Excellent Good Poor	Comments _____
• How Do (occupation) Use Math section	Excellent Good Poor	Comments _____
• What Training, Education, and Experience Do You Need To Become A (occupation) section	Excellent Good Poor	Comments _____
• Individual Simulation section	Excellent Good Poor	Comments _____
• More Problems section	Excellent Good Poor	Comments _____
• Group Simulation section	Excellent Good Poor	Comments _____

Directions: When completing questions 12-17, please proceed as follows:

- Place a check in one of the boxes for each of the initial questions raised regarding each objective.
- Respond to the third question for each objective by specifying a concrete change/improvement that you feel should be made in the materials, activities, etc.

12. OBJECTIVE

- To help students acquire information about selected entry-level occupations (i.e., occupations for which training is generally provided at the secondary level)

Of what value to students are the concepts, technical information, activities, and related materials to achieving this objective?

___ Of considerable value
___ Of above average value
___ Of average value
___ Of below average value
___ Of little or no value

How much will the various concepts, technical information, activities, and related materials presented to students help them meet this objective?

___ Considerable help
___ Above average help
___ Average help
___ Little or No help

What one change do you feel could/should be made to improve the concepts, technical information, activities, and related materials so as to help students better meet this objective?

13. OBJECTIVE

- To help students discover how different workers use basic math skills on the job every day

Of what value to students are the concepts, technical information, activities, and related materials to achieving this objective?

___ Of considerable value
___ Of above average value
___ Of average value
___ Of below average value
___ Of little or no value

How much will the various concepts, technical information, activities, and related materials presented to students help them meet this objective?

___ Considerable help
___ Above average help
___ Average help
___ Little or No help

What one change do you feel could/should be made to improve the concepts, technical information, activities, and related materials so as to help students better meet this objective?

14. OBJECTIVE

- To help students realize that the basic math skills taught at the secondary level are fundamental to the performance of many jobs

Of what value to students are the concepts, technical information, activities, and related materials to achieving this objective?

___ Of considerable value
___ Of above average value
___ Of average value
___ Of below average value
___ Of little or no value

How much will the various concepts, technical information, activities, and related materials presented to students help them meet this objective?

___ Considerable help
___ Above average help
___ Average help
___ Little or No help

What one change do you feel could/should be made to improve the concepts, technical information, activities, and related materials so as to help students better meet this objective?

15. OBJECTIVE

- To provide students with an opportunity to perform (simulate) occupational tasks that require the application of their basic math skills

Of what value to students are the concepts, technical information, activities, and related materials to achieving this objective?

___ Of considerable value
___ Of above average value
___ Of average value
___ Of below average value
___ Of little or no value

How much will the various concepts, technical information, activities, and related materials presented to students help them meet this objective?

___ Considerable help
___ Above average help
___ Average help
___ Little or No help

What one change do you feel could/should be made to improve the concepts, technical information, activities, and related materials so as to help students better meet this objective?

16. OBJECTIVE

- To help students become more familiar with the entry requirements for the occupations addressed

Of what value to students are the concepts, technical information, activities, and related materials to achieving this objective?

___ Of considerable value
___ Of above average value
___ Of average value
___ Of below average value
___ Of little or no value

How much will the various concepts, technical information, activities, and related materials presented to students help them meet this objective?

___ Considerable help
___ Above average help
___ Average help
___ Little or No help

What one change do you feel could/should be made to improve the concepts, technical information, activities, and related materials so as to help students better meet this objective?

17. OBJECTIVE

• To provide students with an opportunity to consider the future education and training requirements for preferred occupations	Of what value to students are the concepts, technical information, activities, and related materials to achieving this objective?	How much will the various concepts, technical information, activities, and related materials presented to students help them meet this objective?
	___ Of considerable value	___ Considerable help
	___ Of above average value	___ Above average help
	___ Of average value	___ Average help
	___ Of below average value	___ Little or No help
	___ Of little or no value	

What one change do you feel could/should be made to improve the concepts, technical information, activities, and related materials so as to help students better meet this objective?

18. Any additional comments?

APPENDIX K

Fact Sheet

MATH on the job

MATH ON THE JOB--

A series of thirty (30) booklets that provide special needs high school students an opportunity to explore careers and practice math skills simultaneously.

Each booklet--

- Focuses upon an occupation for which the relative number of potential openings is large and does not require a college degree for entry.
- Helps students learn how basic math skills are used by workers on the job.
- Presents information at a reading level that is as low as possible while still conveying concepts that are relevant to adolescents and adults.
- Contains four different math applications relevant to the occupation. Each math application--
  - provides clear and detailed instructions
  - ensures ample opportunity for repetition, practice, feedback, and reinforcement.
- Motivates students to solve occupationally-specific math problems.
- Supplements and reinforces classroom learning.
- Focuses upon an occupation that students can experience in a typical high school general or vocational education classroom.
- Provides students the opportunity to practice math-related applications in a sequenced series of problems.

Occupations Selected

Taking into consideration the appropriateness of occupations for the target populations, independent consultants helped the National Center rank and select the following thirty (30) occupations:

1. Cook
2. Motor-vehicle mechanic
3. Carpenter
4. Painter
5. Local truck driver
6. Waiter/waitress
7. Receiving clerk
8. Sales clerk
9. Construction laborer
10. Maintenance mechanic
11. Secretary/clerk typist
12. Cashier
13. Janitor/maintenance person
14. Grain farmer
15. Plumber
16. Taxi driver
17. Tractor-trailer driver
18. Combination welder
19. Electrician
20. Machinist
21. Meat cutter
22. Barber/cosmetologist
23. Heavy equipment operator
24. Metal product assembler
25. Nurse aide/assistant
26. Accounting clerk/bookkeeper
27. Computer service technician
28. Programmer
29. Radio/TV service person
30. Sheet-metal worker

Development Process

- Developed under a grant from the U.S. Department of Education, Office of Special Education and Rehabilitation Services, by the National Center for Research in Vocational Education.
- Development staff possessed a unique blend of expertise in curriculum development, research, special education, vocational education, instructional design, and mathematics.
- Extensive revision and material refinement has taken place after pilot-testing and field-testing the materials.

- The test sites were--
  - Greenville, South Carolina
  - St. Louis, Missouri
  - Salinas, California
  - Milwaukee, Wisconsin

Format and Content

- Total of 555 pages for all 30 booklets
- Average booklet length is 18 pages (range 15-21)
- Total of 1,352 math problems
- Average number of math problems in each booklet is 45 (range 25-80)
- Each booklet provides information on--
  - what the worker does
  - where the worker works
  - how the worker uses math
  - what things the worker needs to know
  - what courses, training, and experience the worker needs to enter the occupation
- Math concepts include--
  - whole numbers
    addition
    subtraction
    multiplication
    division
  - common fractions
    equivalents
    simplifying
    improper
    mixed
    addition
    subtraction
    multiplication
    division
    converting to decimals
  - decimals
    place value
    rounding
    addition
    subtraction
    multiplication
    division
    converting to common fractions

- measurement
  English system
  metric system
  addition
  subtraction
  multiplication
  division
  area
  volume
  tolerance
  time

- measurement instruments
  scales
  dry
  liquid
  rules

other
  ratio and proportion
  scale drawings
  angles
  money
  counting
  reading tables

Representative Comments about Materials

"Congratulations to your staff on their creativity."

"I am looking forward to seeing all sets on the market."

"The materials are quite impressive. We would like to receive information regarding acquisition of the final drafts."

"I wish there were more units available. Many of my students did not believe that math was used in so many occupations."

"How soon will the materials be available for purchase?"

APPENDIX L

Draft Brochure

PANEL 1

MATH
ON THE JOB

Teach BASIC SKILLS
while students
EXPLORE CAREERS

Developed by:

The National Center for Research in
Vocational Education

Published by:

PANELS 2 & 3

FOUR REGIONAL CONFERENCES ON
MATH ON THE JOB

THE PRODUCT

MATH ON THE JOB is a unique set of classroom materials that focus on helping students learn how basic math skills are used by workers in 30 different occupations. Designed to improve and reinforce basic math skills, these 30 booklets also will assist students explore a variety of careers from the trade areas such as "carpenter" and "electrician" to high tech areas such as "computer service technician" and "programmer". Written at a low reading level these occupational booklets will not only increase students' career awareness levels, but will also provide increased motivation for learning and applying basic math skills.

MATH ON THE JOB is a practical tool that teachers can use to generate career exploration activities. Although designed for special education students who are either developmentally, emotionally, or learning disabled, these booklets are ideal for all students from 5th through 10th grades who are interested in exploring the job market. For every occupation included in the series, each booklet describes:

- What the worker does.
- Where the worker works.
- How the worker uses math.
- The training, education and experience a student needs to enter the occupation.
- Four different math applications that the worker uses on the job.

Not only does each booklet focus on an occupation that students can experience in a typical high school, general, or vocational classroom, MATH ON THE JOB also motivates students to solve occupationally specific math problems.

CONFERENCE PURPOSE

Four regional conferences are being jointly sponsored by The National Academy of the National Center for Research in Vocational Education and Publishing Company. The purpose of these conferences is to provide educators with a comprehensive career education program that reinforces basic skills through the combination of computer assisted instruction and print based classroom materials.

OBJECTIVES

Participants who attend these conferences will be able to:

- o Review alternative strategies for linking basic skills to career education.
- o Explore careers through computer assisted instruction.
- o Review materials that reinforce basic skills while providing opportunities for career exploration.

WHO SHOULD ATTEND

Personnel who will benefit from these conferences include math teachers, special education teachers, career education specialists, district level supervisors of curriculum, guidance counselors, and vocational instructors.

CONFERENCE FORMAT

Each conference will begin at 8:30 a.m. and conclude by 5:00 p.m. On-site registration will be from 8:00 - 8:30. Refreshments and lunch will be provided.

PANEL 4

Mailing label panel so brochure can be self mailed.

National Center for Research
in Vocational Education
1960 Kenny Road
Columbus, Ohio

Mailing Label

PANEL 5

THIRTY OCCUPATIONS

Teach and reinforce basic math skills while your students explore the following careers:

1. Cook
2. Motor-vehicle mechanic
3. Carpenter
4. Painter
5. Local truck driver
6. Waiter/waitress
7. Receiving clerk
8. Sales clerk
9. Construction laborer
10. Maintenance mechanic
11. Secretary/clerk typist
12. Cashier
13. Janitor/maintenance person
14. Grain farmer
15. Plumber
16. Taxi driver
17. Tractor-trailer driver
18. Combination welder
19. Electrician
20. Machinist
21. Meat cutter
22. Barber/cosmetologist
23. Heavy equipment operator
24. Metal product assembler
25. Nurse aide/assistant
26. Accounting clerk/bookkeeper
27. Computer service technician
28. Programmer
29. Radio/TV service person
30. Sheet-metal worker

PANEL 6

REGISTRATION INFORMATION

The instructional fee for each conference is $50.00 per person. This covers the cost of instructional materials and refreshments. Registration may be made by returning the attached registration form along with your check or by indicating on the form how payment will be made. Telephone or on-site registration will also be accepted if a purchase order or written guarantee of payment from the institution is provided.

EARLY REGISTRATION IS ESSENTIAL! These conferences operate on a cost-recovery basis; thus, a minimum number of participants are needed to offer these programs. Telephone registration or inquiries should be made to 800-848-4815 outside Ohio or 614-486-3655 ext. 22 in Ohio. Telex number: 8104821894. Cable number: CTVOCEDOSU/Columbus, Ohio.

Cancellations must be received five (5) working days prior to the starting date of the activity in order to receive a refund or avoid billing if insufficient registration necessitates cancelling the activity, the full instructional fee will be refunded. There is no charge for participant substitutions.

HOTEL ACCOMMODATIONS

A block of rooms has been reserved at a special rate for program participants at each conference location. For reservations, please contact the hotel directly and identify yourself as a participant in the National Center for Research in Vocational Education Conference on Linking Basic Skills to Career Education.

Rooms will be released by each hotel at 6:00 p.m. on scheduled day of arrival unless guaranteed by credit card or one night's deposit.

PANEL 7

REGISTRATION FORM

Please register me for the MATH ON THE JOB Conference scheduled for:

_____ April 24, 1986 Columbus, Ohio	_____ May 1, 1986 Salt Lake City, Utah	_____ May 8, 1986 Redwood City California

Name:
Organization:
Address:
City: State: Zip: Telephone:

Make checks payable to: The National Academy for Vocational Education and mail to: The National Center for Research in Vocational Education, The Ohio State University, 1960 Kenny Road, Columbus, Ohio 43210.

PANEL 8

Mail back for the registration form.

_____
_____
_____

The Ohio State University
The National Center for Research
in Vocational Education
1960 Kenny Road
Columbus, Ohio 43220

APPENDIX M

Marketing Plan

MATH ON THE JOB

The Product

MATH ON THE JOB is a unique set of classroom materials that focus on helping students learn how basic math skills are used by workers in 30 different occupations. The materials were developed under a grant from the U.S. Department of Education, Office of Special Education and Rehabilitative Services.

Designed to improve and reinforce basic math skills, these occupational booklets also will assist students in exploring a variety of careers from the trade areas such as "Carpenter" and "Electrician" to high tech areas such as "Computer Service Technician" and "Programmer".

Written at a low reading level, these occupational booklets w ll not only increase students' career awareness levels, but will also provide increased motivation for learning basic math skills.

Through a field test in four sites across the country, 23 different teachers used the booklets with over 80 students. Extensive revisions and refinements have been made as a result of the input of these teachers and students.

MATH ON THE JOB is a practical tool that teachers can use to generate career exploration activities as well as to teach basic math. Not only are these materials ideal for students from 5th through 10th grades who are interested in exploring careers, they were actually targeted to the 1,731,393 students who are either learning disabled, developmentally disabled, or emotionally disturbed (Digest for Data for Persons with Disabilities, 1984). Therefore, these materials will appeal not only to elementary teachers, math teachers and vocational instructors, but also to special education personnel.

Target Audiences

Although the primary users of MATH ON THE JOB will be math teachers, career educators, vocational instructors and special education personnel, additional users and decision makers in the purchasing process need to be made aware of and interested in these materials. These individuals are identified as the secondary users.

Primary Users - Teachers

Math Teachers	42,478
Remedial Math Teachers	2,973
Special Education Teachers	75,695
Vocational Teachers	5,887
Agriculture Teachers	6,214
Distributive Education Teachers	2,879
Consumer Education Teachers	20,303
Computer Programming Teachers	3,337
Bbusines Education Teachers	29,293
Trade/Industrial Teachers	33,016
TOTAL	222,075

Secondary Users

Vocational Education - District Level Supervisors

Curriculum Instruction, K-12	4,198
Business Education	3,352
Vocational Education	3,936
Industrial Arts	3,461
Home Economics/Consumer Education	3,255
Career Education, K-12	1,962
Inservice Training/Staff Development	1,861

Special Education - District Level Supervisors

Curriculum Instruction, K-12	4,198
Special Education, K-12	6,935

Teacher Buyers

Grades 4-6	192,748
Grades 5-8	13,154
Grades 7-9	59,524
Grades 7-12	7,687
Grades 8-10	4,809

Other

Adult Education Personnel	9,970
Teacher Inservice Center Personnel	271
Guidance Counselors	15,183
JTPA Directors	447
State Administrators/Supervisors	
Business & Office	54
Marketing	54
Trade and Industrial	54
Guidance & Counseling	54
Career Education	54

Options for Marketing Math on the Job

The following ideas for marketing this product are based on the National Center's involvement in the development of the product and experiences with the educational market. They are offered as possible options for the publisher to consider.

The process of decision making for educational products is special; the final decision maker is not necessarily the user of the product. Other audiences may control the resources to purchase materials. Purchasing processes differ among school districts. In small districts, it is possible for a teacher to request and obtain approval from supervisors and administrators within a few weeks, while in a larger school district the process may require up to four months. Furthermore, the timing of the purchase is crucial within the funding cycle of the school year.

Our suggestions include several promotional levels needed to reach the widest market of potential users with cost-effective techniques. One strategy is to spread awareness and interest among the user audiences prior to publication, with discounts for early orders. Follow-up with this audience can produce orders and endorsements to use with secondary audiences.

Action Plan

Since the innovators, or first purchasers, tend to number fewer than 5%, and the school purchasing process is slow, a large pool of awareness and interest needs to be built over time.

Key audiences may be reached in a planned array of both direct and indirect activities aimed toward awareness, interest, choice, and purchase.

National Center Direct and Ongoing Contacts

The National Center is in a unique position to provide important support in the promotion of MATH ON THE JOB through our many direct contacts with all levels of the educational community, nationwide. As the developer of MATH ON THE JOB, we will display the product, distribute literature, and provide information through our many field contacts, such as--

800 Service Number

Inquiries are received daily from educators across the nation. Responses about products, training opportunities, and other assistance not only lead to further sales, but also to the identification of additional user clients.

National, Regional, and Local Exhibits and Displays

National Center experts provide excellent opportunities for contacts with large numbers of potential users who look to the National Center for leadership on the newest--and best--in career development products. Major exhibits include the conventions of the Council for Exceptional Children, Corrections Education Association, American Association for Counseling and Development, American Vocational Special Needs Personnel Association and more. In addition, we provide product literature to hundreds of targeted local and state meetings and workshops.

Presentations and Workshops

National Center staff make many presentations during the year at professional meetings and workshops. In addition, the National Academy for Vocational Education provides product displays and information at their national and regional workshops conducted throughout the year.

National Center Meetings

Each year educators, business, industry, labor, and government staff attend hundreds of meetings held at the national Center. Appropriate information and product displays are provided at these meetings.

National Center Listings

Products developed by the National Center are entered into the Educational Resources Information Center (ERIC) the major national database covering all areas of education. This system is readily available to educators and provides descriptions and availability information.

VECM--(Vocational Education Curriculum Materials)

The comprehensive vocational education curriculum materials databases containing information on printed, media and computer-assisted curriculum.

The National Center product catalog and topical brochures include complete availability information and are distributed nationwide.

National Center support, used as a supplement to the publisher's marketing campaign, not only broadens the client base, but assures awareness among decision makers who are not readily reached through standard marketing techniques.

Suggested Promotional Approaches

Phase I Prepublication Activities

Mailings-- A prepublication mailing to user audiences can include a prepublication brochure offering an early-order discount and a sample.

A follow-up mailing can be sent (with a response form) asking if recipients received the complimentary sample, requesting their comments about the publication, and reminding them of the deadlines for discount ordering. Possible endorsements may be followed up for use later.

Phase II Publication Date and Continuing

Announcement Mailing to Secondary Audiences--A letter and final brochure may be sent to potential users and to suppliers such as instructional/media centers, teacher centers, and to targeted associations, district supervisors, and other groups.

The ripple effect of the large mailings can result in reaching additional target groups within the educational community.

News Releases to Journals and Newsletters--We have found this to be an effective vehicle to reach large numbers of potential users. Releases are timed for the issue nearest the product publication date. Examples are--

- National Council of Teachers of Mathematics
  "Mathematics Teacher"
  "News Bulletin"
- Council for Exceptional Children
- Association for Children and Adults with Learning Disabilities
- American Association for Counseling and Development
- American Vocational Education
- Association for Supervision and Curriculum Development

Feature Articles--These may be developed as a follow-up to news releases or submitted to journal publishers.

Journals/Newletter

Council for Exceptional Children
1. Exceptional Children (6/yr)
2. Exceptional Child Education Resources (4/yr)
3. Teaching Exceptional Children (4/yr)

Association for Children and Adults with Learning Disabilities
1. Newsbriefs (bimonthly)

Association for Supervision and Curriculum Development
1. Educational Leadership (8/yr)
2. Update (newsletter)

American Vocational Association
1. Update
2. Vocaional Educational Journal

American Association for Counseling and Development

1. Guidepost (newsletter 18/yr)
2. Journal of Counseling & Development (10/yr)
3. Journal of College Student Personnel (bimonthly)
4. School Counselor (5/yr)
5. Counseling and Values (quarterly)
6. Counseling Education and Supervision (quarterly)
7. Journal of Employment Counseling (quarterly)
8. Journal of Humanist Education & Development (quarterly)
9. Journal of Non-white Concerns in Personnel & Guidance (quarterly)
10. Measurement & Evaluation Counseling & Development (quarterly)
11. Rehabilitation Counseling Bulletin (quarterly)
12. Vocational Guidance Quarterly
13. AMHCA Journal (semiannual)

Specialized Announcements

These may be submitted to educational information systems such as SPECIAL NET and ADVOCNET.

Advertisements

In addition to ads in educational journals and newsletters, promotional literature in "The Conventioneer" is an effective way to reach audiences at numerous national conventions. "The Conventioneer" is usually kept after the convention by participants who use it as a desk reference.

Phase III

Follow-up Mailing

A follow-up mailing targeted to selected suppliers and users may provide the final impetus for a sale. For example, a marketing to 7,000 of the 15,500 school districts would cover 90% of the available purchase dollars.

These suggestions for the educational audiences are based on the expertise of National Center staff, who are primarily educators, and on the experience of marketing National Center products among our colleagues. More detailed information is available in support of collaborative arrangements with publishers.

APPENDIX N

Draft News Release

NEWSLETTER ANNOUNCEMENT/NEWS RELEASE:
(Conventional or Electronic)

ANNOUNCING --

NEW BASIC SKILLS/CAREER ED PRODUCTS

MATH ON THE JOB is a series of 30 occupationally - specific booklets that reinforce basic math skills while students explore 30 different occupations. Written at a low reading level, these booklets will not only increase students' career awareness levels, but will also provide increased motivation for learning basic math skills. Each booklet provides information on:

- o What the worker does.
- o Where the worker works.
- o How the worker uses math.
- o What things the worker need to know.
- o What courses, training and experience the worker needs to enter the occupation.

In addition to this occupational information, each booklet provides an average of 45 math problems that the worker does on the job.

The thirty occupations included in the series are:

1. Cook
2. Motor-vehicle mechanic
3. Carpenter
4. Painter
5. Local truck driver
6. Waiter/waitress
7. Receiving clerk
8. Sales clerk
9. Construction laborer
10. Maintenance mechanic
11. Secretary/clerk typist
12. Cashier
13. Janitor/maintenance person
14. Grain farmer
15. Plumber
16. Taxi driver
17. Tractor-trailer driver
18. Combination welder
19. Electrician
20. Machinist
21. Meat cutter
22. Barber/cosmetologist
23. Heavy equipment operator
24. Metal product assembler

25. Nurse aide/assistant
26. Accounting clerk/bookkeeper
27. Computer service technician
28. Programmer
29. Radio/TV service person
30. Sheet-metal worker

MATH ON THE JOB was developed by the National Center for Research in Vocational Education and is published by _____ Publishing Company. For more information please contact the National Center at 800-848-4815 (toll free outside of Ohio) or 614-486-3655.